# Conceptual Modelling Lab 1

In this lab and the next one, we will work through the Hierarchical Control Conceptual Modelling (HCCM) framework to build a conceptual model, aligned with the HCCM standard from lectures, that represents the practical activity, i.e., making paper cubes, from the earlier lab.

You will work through the steps for HCCM modelling shown below and complete templates for those steps.
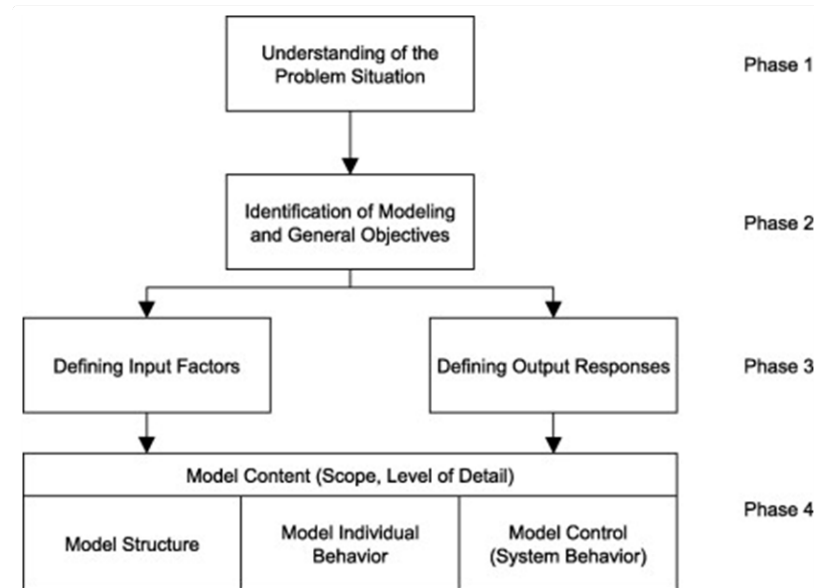
Understanding of the Problem Situation

To understand the problem situation, you need to summarise what is happening in a concise way. There is no strict rule for the best way to do this. One good approach is listening to the problem "holder", i.e., person/people who have the problem such as a client, then reflecting what you have heard in a couple of paragraphs with lists of key details and questions. You can then work through one or more iterations of feedback and refinement to get a final, agreed upon problem description.

In this lab you will provide a problem description of your making paper cubes lab. Shown below are a couple of screenshots from that lab.
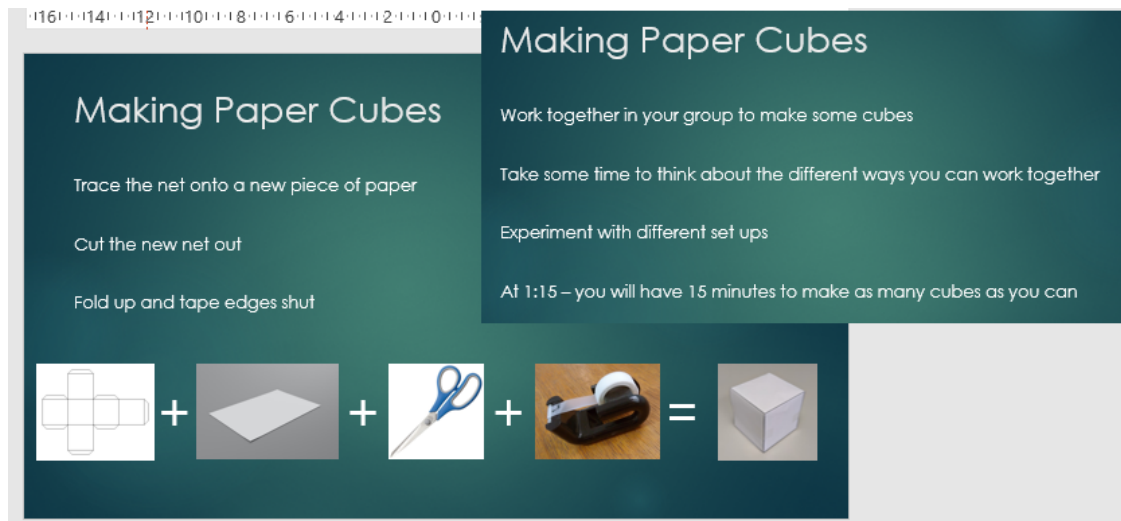
In the box below write problem description for making paper cubes, think about what you are trying to solve/discover by simulating this activity.

To create paper cubes, there are 4 distinct steps. First, a net must be drawn. Secondly the net must be cut out. At Some point during this process, tape must be cut. Lastly the net must be folded and taped together.

Our goal is to maximise the cube production rate, so that at steady state, we can produce as many cubes per minute as possible. And we also want to know the maximum rate is.

The amount of time that each of the individual steps takes can be taken from a normal distribution (assuming iid).

Identification of Modelling and General Objectives

As described in lectures, there are two types of objectives to consider when developing a simulation:

> "The second step deals with the determination of the objectives. According to Robinson [26] they drive all aspects of the modeling process and are a subset of an organizations aims. Further, objectives can be classified into modeling and general objectives, where the latter are concerned with the flexibility, run-speed, visual-display and model/component reuse."

Modelling Objectives

In the box below write the modelling objectives for making paper cubes, i.e., what are you trying to discover using simulation?

The modelling objectives are:

1. To maximise the efficiency of cube production (cubes made per minute)
2. To determine the maximum cube production rate

General Objectives

In the box below write the general objectives for making paper cubes, i.e., what are some of the general properties you'd like your simulation to have?

> We Would like our cubes to be accurately built and to meet the specifications required of them.
>
> Plausible implementation, that helps in real production.
>
> doesn't take forever to run

Defining Input Factors

Input factors are things that can be changed and may modify how a system behaves/performs. They are often defined to create multiple different scenarios to compare via simulation.

In the box below write the input factors for making paper cubes.

> The input factors are:
>
> 1. The time taken to draw each net
> 2. The time taken to cut each net
> 3. The time taken to fold/tape each net
> 4. The time taken to cut tape
>
> 5. The number of people working (assuming >=4)
> 6. the number of resources available
> (e.g. how many scissors, amount of tape, amount of space for tape)

Defining Output Responses

Output responses are things that can be measured and compared to understand how a system has behaved/performed. They are the metrics used to compare different simulation scenarios.

   In the box below write the input factors for making paper cubes.

Output responses:

The maximum rate of cube production

CHECKPOINT Get the lab tutors to review and mark off your conceptual modelling work up to this point.

Model Content

For the model content definition of our conceptual model we will follow the new HCCM standard. This standard is presented in an academic article (currently under review) that is available on Canvas under `Files > Lectures > Conceptual Modelling` in the file `hccm-standard.pdf`

Identifying Entities

Before formally defining entities it is often useful to identify entities in the system and whether they are active, i.e., have behaviour like a doctor or patient, or passive, i.e., are part of the system that should be modelled but that don't have explicit behaviour like a waiting room with a given capacity, but that doesn't actually have defined actions.

   In the box below list the entities for making paper cubes along with whether they are active or passive.

Entities:

Active Entities:
- Net Drawers
- Paper Cutters
- Cube Folders/Tapers
- Tape Cutters
- Individual pairs of scissors

Passive Entities:
- Number of nets
- Number of cut nets
- Number of completed cubes

- Individual paper sheets
- Tape Space (at or below capacity)

Drawing Behavioural Paths

Once preliminary identification of identities has been done, behavioural paths for each of the <mark>active entities</mark> must be drawn. These are essentially flowcharts with a special structure.

The box below contains a behavioural path for scissors and a partial behavioural path for cubes for the making cubes conceptual model.
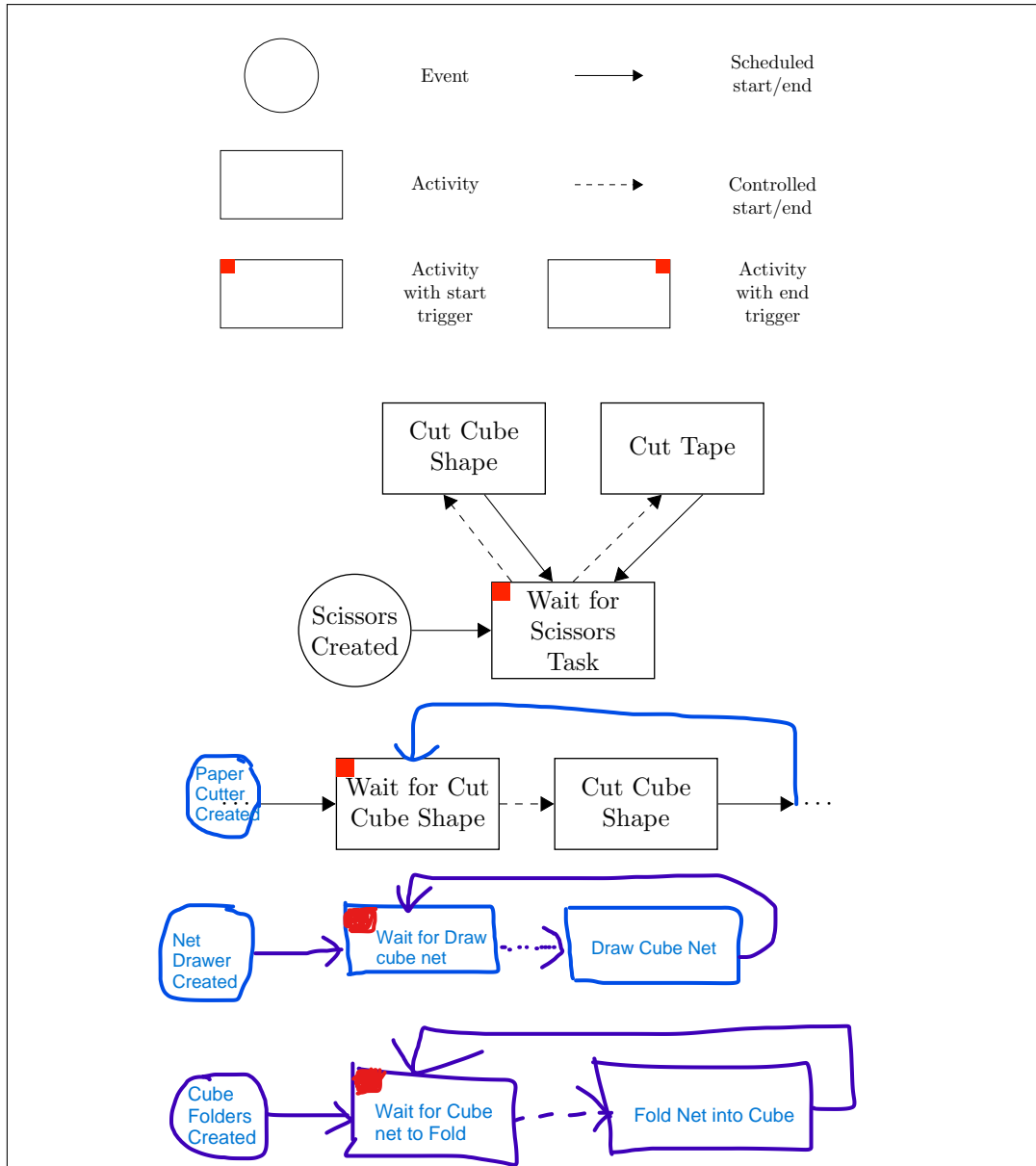
In the following boxes draw behavioural paths for each of the entities listed previously. Be sure to use the same activity name for entities that all participate in the same activity, e.g., "Cut" in the example.
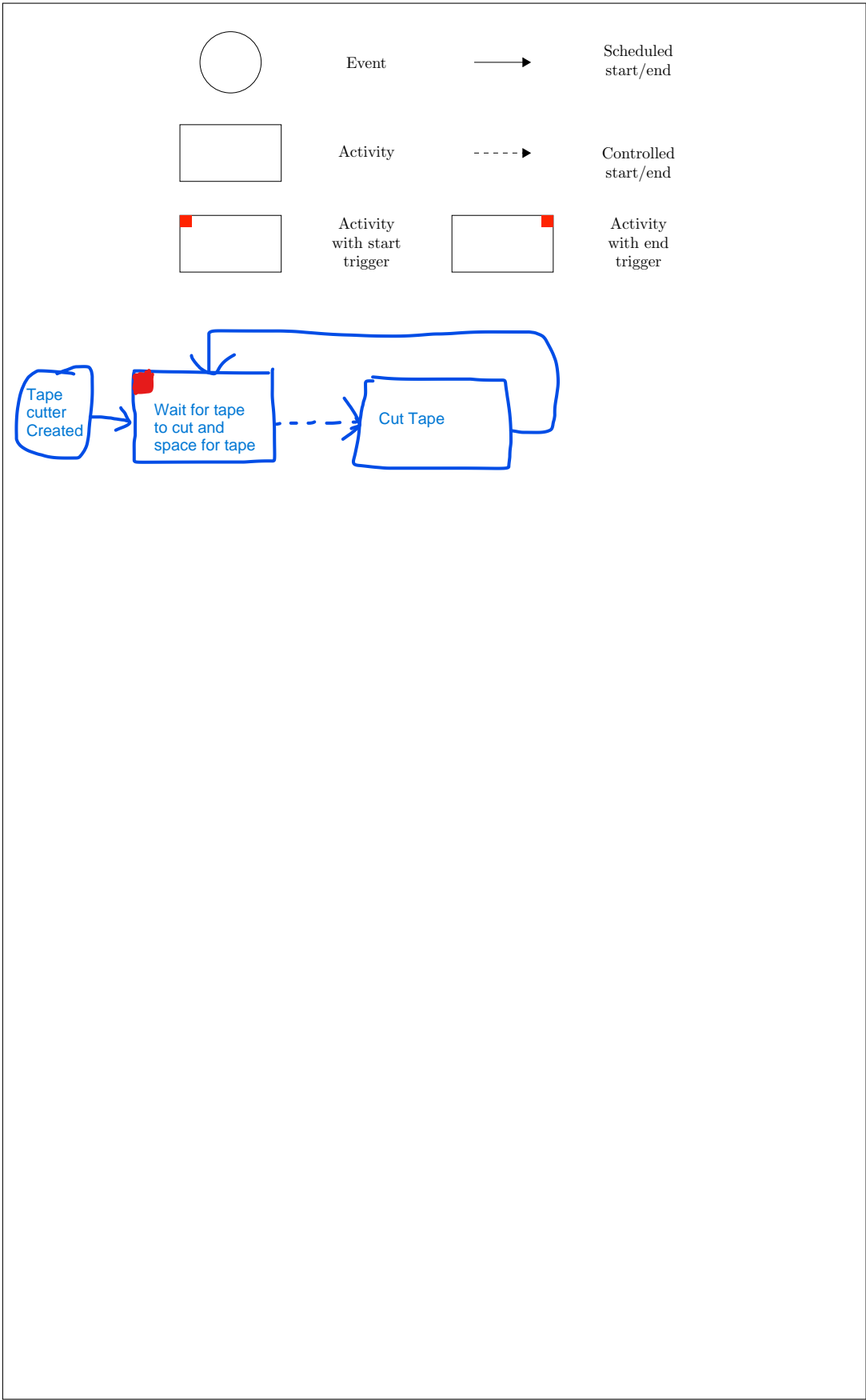
Event

Scheduled
start/end

Activity

Controlled
start/end

Activity
with start
trigger

Activity
with end
trigger

Tape cutter Created → Wait for tape to cut and space for tape ⇢ Cut Tape

Event

Scheduled
start/end

Activity

Controlled
start/end

Activity
with start
trigger

Activity
with end
trigger

Event

Scheduled
start/end

Activity

Controlled
start/end

Activity
with start
trigger

Activity
with end
trigger
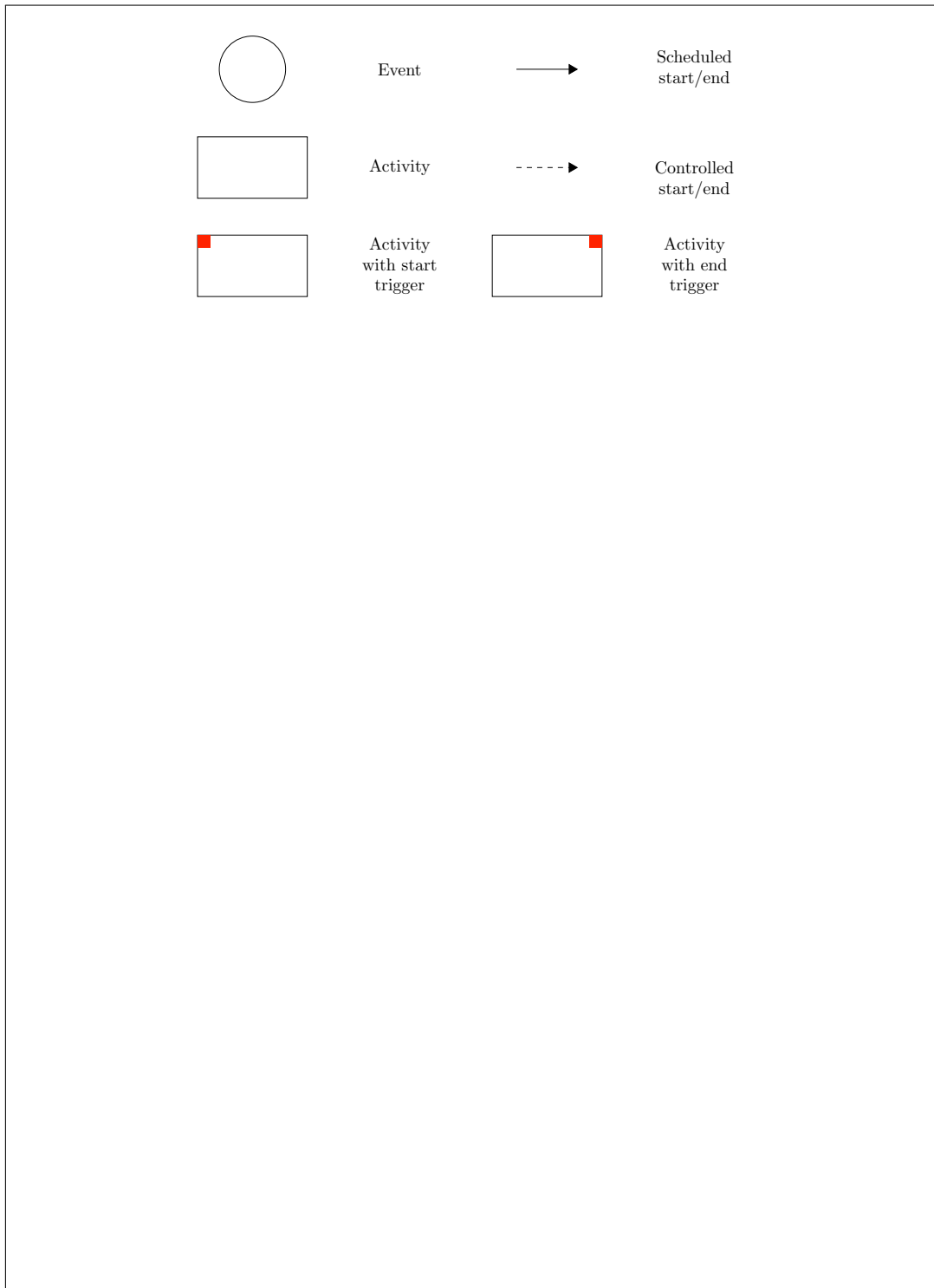
CHECKPOINT Get the lab tutors to review and mark off your entities and behavioural paths.

We will complete the rest of the conceptual model, i.e., the rest of the model content, in our next lab.