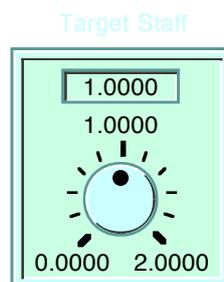
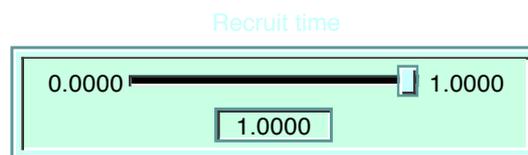


Exploring Models 1 and Interfaces

Stella Guide 3

Goal Seeking & Drifting Goal



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Staff Recruitment - Background

A firm wishes to recruit staff until it reaches a set target level. To achieve this target the firm measures the staff shortage and recruits in proportion to that shortage. Thus the number of staff increases, the shortage decreases and the recruitment is again adjusted accordingly. This is an example of a policy with information **feedback**, the cause influences the effect which in turn influences the cause – a **feedback loop**.

This feedback loop is balancing. The firm recruits so many staff in a set time but slows down the recruitment as the number of staff reaches the target level. I.e. as the staff shortage gets less - the recruitment rate is reduced. Thus equilibrium is achieved.

This is an example of **goal seeking behaviour**.

Some Maths

Some interpretation is needed on the set time over which staff are recruited, the “recruitment time”.

The recruitment rate is the number of staff recruited per month. As a formula it is staff shortage divided by “recruitment time”:

$$\text{recruitment rate} = \text{difference between target staff and current level} / \text{recruitment time}$$

Because this is a continuous system, recruitment time is related to the time taken to half the staff shortage by:

$$\text{recruitment time} = \text{time to half the staff shortage} / \ln(2)$$

Thus a recruitment time of 3 months means it roughly halves its value in 2 months. The log comes from the decaying exponential solution to the problem.

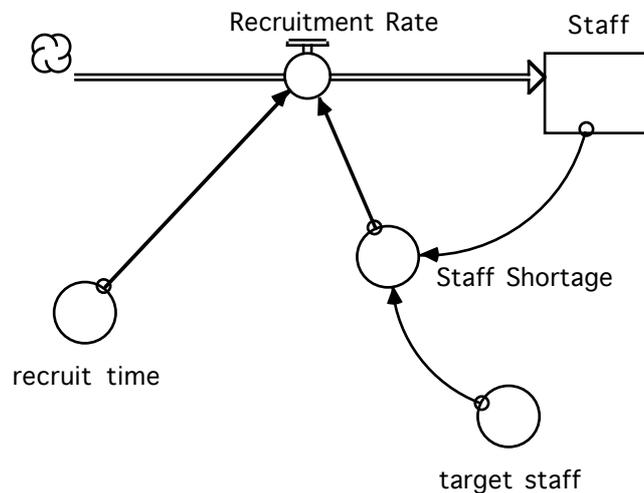
Put another way a recruitment time of 3 months means that in 3 months staff shortage drops to 35% of its starting value.

The Problem

A firm recruits staff according to the above policy. However because staff leave they find they are permanently under recruiting. This is one example of the **drifting goal** archetype. Advise them on a different recruitment policy.

Exercise 1 Staff Recruitment - Model Construction

- *Start up Stella*
- *Place the following staff recruitment model into the modelling layer of Stella*



- Click on the boxes and

Initial Staff = 0

Recruitment_Rate = Staff_Shortage/recruit_time

recruit_time = 3

Staff_Shortage = target_staff - Staff

target_staff = 30

- *Save your model*
- *Set the run time to 26 and the method to RK4*

At present don't run the model but *identify* the feedback loop on the above diagram and *place in* the signs (+ or -) of the links to show it is a balancing loop. (Use a pen on this paper!)

Parameters

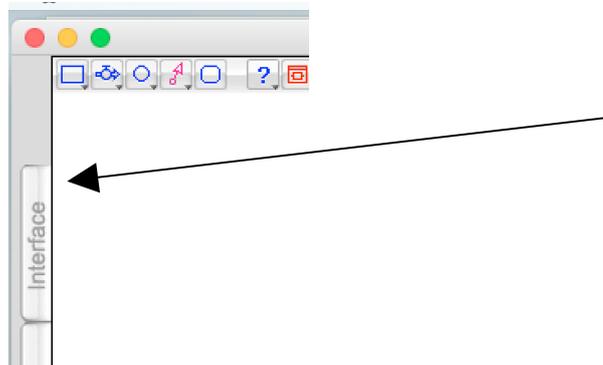
This is Important!!!

This model has two parameters: recruitment time and target staff. **You can tell they are parameters because there are no information links (connectors) going into them, but there are connectors going out into the model.**

To make it easier to change parameter values the next exercise will be to put a user interface on the top level of Stella.

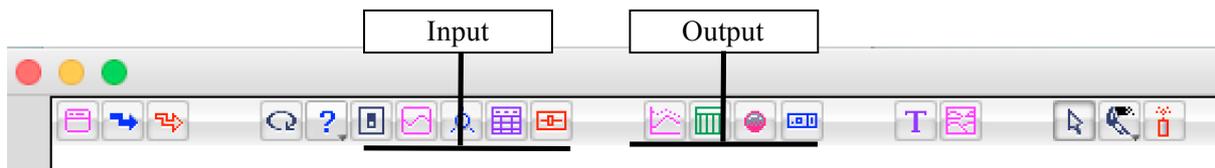
Exercise 2 - Input and Output Interface

- Move to the top layer of Stella by clicking the up navigation arrow:



The screen should now be blank.

Note the new icons for input and output.



We won't need to use them all but you may like to experiment later.

Input

We will place one slider to control the recruitment time.

- Select the slider:



You should find the slider appears.
It can be moved anywhere



- To attach it to recruitment time *double click the slider*.
- Click on recruit_time to attach it to the slider and set min and max to 0.1 and 10 respectively.
- Click OK and you should see your slider ready to make changes to the recruitment time.
- Set up a slider for The Target Staff as well.

Output

Set up a graph, as in the last lab. This time select both Staff and Target Staff to place on the graph together.

By default they will be plotted on different scales. To place on the same scale:

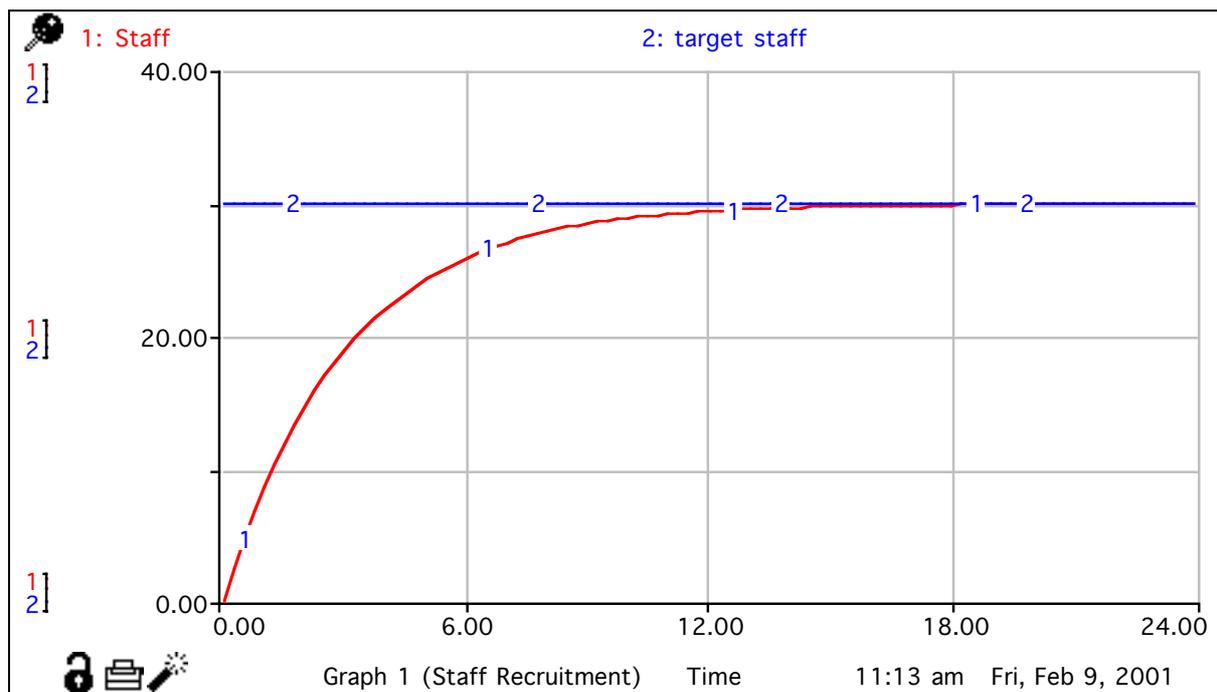
- *Click* Staff
- *Hold* the control key and *click* target staff - Both should remain highlighted
- *Double click* the scale icon to the right of the selected value for Staff

You may now set the scale as in the last lab - but the same scale applies to both. The scale should be 0 to 40.

Remember target staff is 30 so it should never go over this value

Simulation

Run the model. You should see:



Clearly the target is achieved.

Try some lower and some higher values of the recruitment time (by moving the slider) to see the target being achieved faster and slower respectively.

Note it is stable - 30 is the equilibrium value. This is the goal-seeking template which is a balancing loop.

Click here to return slider to default value

recruit time

0.1000 ▬ 10.0000

U

5.6440

You can type numbers in directly here. Click away from slider and it moves into place

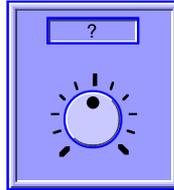
Exercise 2 Path Independence

Place in a rotary control to set the initial value of Staff.

- *Select the rotary control*



The rotary control will appear



To attach it to the initial value of staff *double click the control*.

- *Click* on Staff to attach it to the slider and set min and max to 0 and 30 respectively.
- *Click* OK

This control will set the initial value of Staff.

Run simulations with different initial values of Staff. Try: 5, 10, and 20.

You should find that although the simulations start in different places they all end up in the SAME place. that is the target of 30. This phenomena is called PATH INDEPENDENCE. The initial value does not determine the final value.

This is to be expected in a goal-seeking model as we always want to end up at the target!

Later you will see path dependent models.

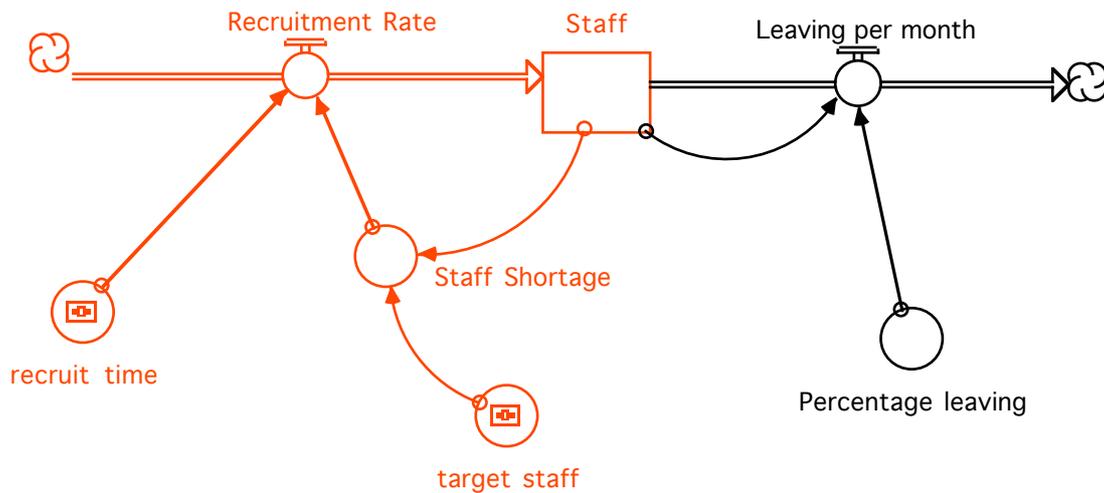
Exercise 2 Staff Leaving

Extend the Model

Of course staff are not just recruited, they also leave.

Model leaving with a draining process so that a fixed percentage leave each month.

- Back to the modelling layer and make the additions:



- Click Leaving per month and percentage leaving and set:

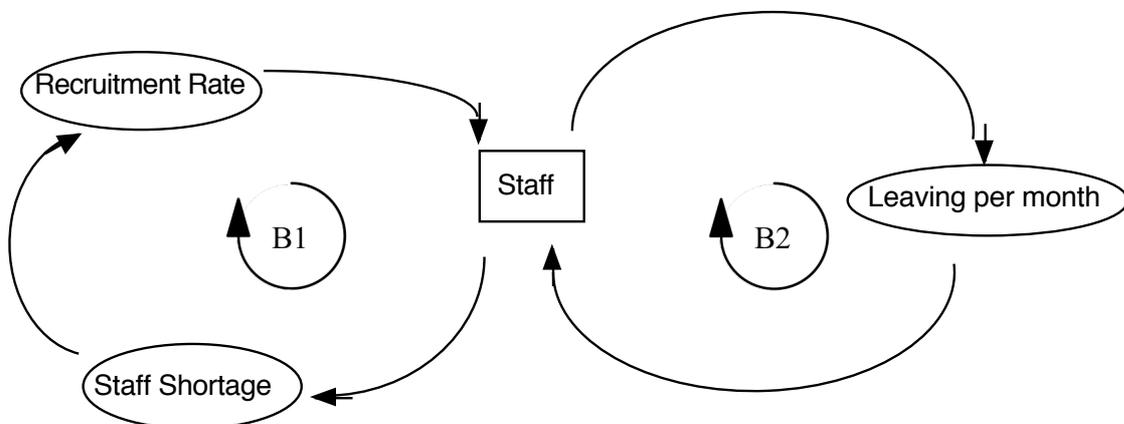
$$\begin{aligned} \text{Leaving_per_month} &= \text{Percentage_leaving} * \text{Staff} \\ \text{Percentage_leaving} &= .05 \end{aligned}$$

The formula is a product because it is the draining process. Place in the + and - on the balancing loop between staff and leaving per month. 5% of the staff leave each month.

Simulation

Back to Interface layer. Run the simulation and note that the recruitment goal is no longer reached.

REASON - There are now two balancing loops affecting Staff. Place on the signs on:



The additional balancing loop through leaving causes the systems to miss its goal. This is the **drifting goal** scenario.

Fix 1 - Adjust Recruitment time

You cannot adjust the leaving rate. A firm may have no control over this - so don't set up a slider!

Question: Does adjusting the recruitment time make the goal easier to achieve.

As a mathematician you should be able to prove this cannot be done. (In class!)

Fix 2 - Adjust "Goal"

You could try adjusting the Target Staff to an artificially higher value to see if you can hit 30 Staff.

To get an exact value Staff set up a numeric display



Then double click on the numeric display and set it up for Staff. Make sure that "retain end value" is clicked.

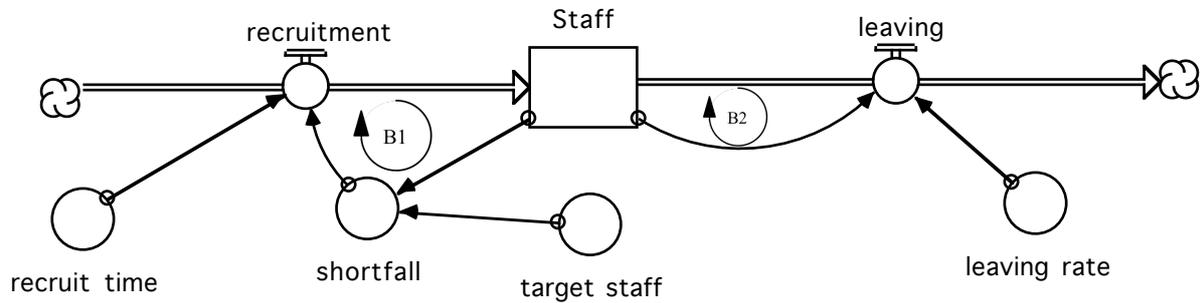
Write down the value of the Target Staff needed to get Staff to 30

Why can't this method work in practice?
(Answer in class)

Question: Can you think of any other ways you could achieve a staff of 30?

Debrief of Drifting Goal

Consider the goal seeking with staff leaving



This is called a Drifting Goal Archetype. The second balancing loop (B2) causes the first loop (B1) to fall short of its target. As the system stands there is nothing that can be done to hit the target, The fault is not with the value of any of the parameters but with the system's structure – in particular the recruitment policy. As such the problem of the drifting goal will only be solved by changing the system's structure.

A similar effect is noted when people lower their standards in order to make them easier to achieve. Instead they just fall short of the lower target. Indeed lowering standards just leads to even lower standards with no success achieved. This process can be formalised as a model of how a goal keeps drifting.