The Polyface Farm Model

A learning approach towards Empirical Modelling

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Abstract

In this paper, I describe my little experimental model that's been built with the Empirical Modelling tools and discuss my understandings of the science of Empirical Modelling upon the experience I gained from the modelling process. Formally, the theme falls in the categories of both Interactive Graphic and Educational Technology [1]. However, I would rather describe the model as an animated-spreadsheet look-alike. The model is based on the Polyface Farm. Located in Virginia, US, the farm is famous for its eco-friendly methods and high productivity.

1. INTRODUCTION

The key concept of Empirical Modelling is the use of observation and experiment in building computer-based construal to embody emergent patterns of Observables, Dependencies and Agency [2]. *Observables* are entities; the relationships between the observables are the *dependencies* and an *agent* is an observable that is construed to be responsible for changes to the current status of observables [3].

1.1 The Polyface Farm

In order to illustrate the emphasis of Empirical Modelling and the advantages of its tools, our modelling scenario is better to have entities that are highly dependent to each other, so is the reason why I chose Polyface.

Joel Salatin, the owner of Polyface describes it as a family owned, multi-generational, pasture-based, beyond-organic, local-market farm [4]. The key feature of the farm is its mixture of species on the farm land. Salatin and his family raise a half-dozen different species (grass-fed beef, chickens, pigs, turkeys, and rabbits) in an intricate rotation that has made his 550 hilly acres of pasture and woods in Virginia's Shenandoah Valley one of the most productive and sustainable small farms in America [5].

1.2 Modelling Tools

We will build our model with EDEN (Engine for Definitive Notations) the primary software tool of the Empirical Modelling research group of Warwick. It is intended as a general purpose software tool to assist the implementation of definitive notations [6]. The EDEN language (to be distinguished from the software EDEN) which is the notation of all notations will be used in the model to implement the various observables and dependencies on the farm.

SCOUT (a definitive notation for screen layout) notation is used for constructing the user

interface. SCOUT primarily describes the geometry of the layout of windows in a display. SCOUT windows can also be sensitive so that events (mouse or keyboard actions) happening in that window can be detected [7] and that's what we need for our spreadsheet look alike model.

Although not much of a help in this model, some DONALD (definitive notation for line drawings) notations are also included in the model just to practice the link between DONALD and SCOUT through the SCOUT window.

1.3 Goals

The outcome of our model will be a good illustration of the Polyface Farm model on a conceptual level. People should be able to interact with the model easily and see the advantages of adopting this farming method from that process. The model can also be used as an educational presentation of such "beyond-organic" farming method.

2. IMPLEMENTATION

Due to the scope and limitations of this model, we will not have all details of Polyface in the model. We are happy to have a simple model which can interactively represent the advantage of the Polyface method.

2.1 Our Farm Setup

On our "farm", we have 16 acres of land which is divided into 4 equal pieces. Each piece of land can be used for raising *cattle* or *hens* or both, or can be used to grow *crops*. Animals and crop can't be mixed on the same piece of land. Each piece of land has a crop productivity parameter (pdt – a ratio between 10% and 100%) which is used to represent the level of fertilization of that piece of land (initialised at 10%). The parameter goes up when animals are being raised on it (20% for cattle, 10% for hens), goes down (pdt') after harvest of crops which follow the formula:

$$pbt' = \begin{cases} pdt - 50\% & if\ pdt \geq 60\% \\ 10\% & if\ pdt < 60\% \end{cases}$$

The incomes generated on each piece of land are recorded through another parameter (pgt). Cattle bring \$10 a day while hens bring \$4 a day. Crops are harvested every 3 months and bring:

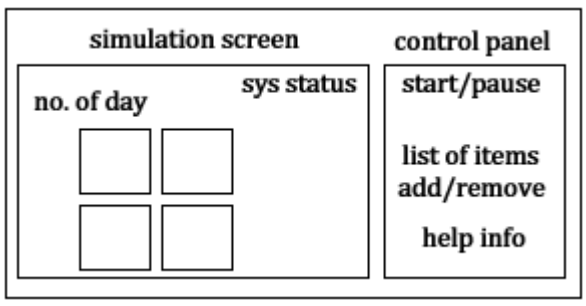
$$pgt = pgt + \$2{,}000 \times pbt$$

So, with 30 days in a month, a piece of land which raises both cattle and hens brings \$1260 every 3 months which is lower than the income brought by growing crops if the pdt of that piece of land is higher than 63%, higher than those with pdt lower than 63%.

Thus, to generate the highest income from the 4 pieces of land, the optimal strategy requires the *player* of the model to keep changing the contents on the lands. First, you need animals on the land to increase its pdt, when it comes to a certain level (around 60%) remove the animals and plant the crops for the next 3 months, then put the animals back on… And so we achieve the goal of showing that a mixture of species generates more profit than a single production.

2.2 Interactive Interface

The screen is divided into two sections. *Farm simulation* on the left (where the animation takes place and the lands are displayed), *control panel* on the right (where you can start/pause the clock and add/remove selected items from the list to the selected land) as illustrated below:



Within the simulation screen, there are four squares each represent a piece of land. On each square, information about that piece of land is displayed including:

- ID of the land (with size);
- Content on the land;
- pdt & pgt of the land;

User can select a piece of land by click on it; same applies for the list on the control panel. Time (Number of days) information is updated every second on the top left of the simulation screen. Information on the lands is updated every second (daily) as well. If the user's operation is invalid (e.g. trying to add an item from the list without selecting a piece of land first), help information will be displayed on the lower part of the control panel.

3. CRITICAL EVALUATION

3.1 Achievements

Firstly, although shrunk in size, the model and its functionality do represent Polyface's general idea of having a mixture of species on one farm.

By assigning different combinations of content to each piece of land and then start the clock, one can see the advantage of Polyface's eco-friendly method very clearly.

The interface is neat. Click (selection) of the land and of the items has a clear response from the interface. The information/help dialogue box in the lower part of the control panel is helpful for the interaction between user and model.

3.2 Potential Improvements

Although the idea of Polyface's method is through with the model, the variables running within the model is far from precise (e.g. hens produce $4 a day, crops harvested every 3 months, etc.). That makes the model weak in presenting a real-life situation. Apart from the variables, the calculation functions for income and productivity improvements are also not realistic (i.e. accident lost can be applied to the animals which influence the steadiness of income).

To close the gap between the model and real-life, we need to obtain more first-hand price and production data and also add in functionalities to represent incidental matters.

There are currently no costs related to the assignment of animal/plant to the land which influences the outcome of the model greatly. This must be corrected in the next version of the model.

Currently, the user can only observe the process on a day-by-day basis. We can add a "planner" utility to set out plan for a long period of time and so that we can get the outcome without waiting.

The data structure for storing the data of the lands is not very clever at the moment (28 integers). A 2-D list can be the answer, but I'm not sure if it is implementable in EDEN. Further, a stand-alone data structure for representing a piece of land would be even better.

Not of great importance, just to note here that a "reset" button and a "speed-up" button alongside the start/pause button would be nice to have. Also, a set of templates of combinations of animal/plant to assign to the lands would help illustrating the model with some pre-set data, thus, makes it a better educational tool.

Bug wise, there is one known. For displaying the number of days, since substr() is used outside str() with a length of 3 on an integer value, when it pass the 999th day, the display goes wrong. That can be fixed by changing the parameter of substr() to 4 but then the early days would have ".00" on the back.

4. CONCLUSION

Although there is still a lot of questions left in this model, it is never the less a neat piece of work.

Without quoting anything from the experts, I can tell from my own experience that apart from the lack of sleep it caused, programming a definitive script is quite fun. An interactive environment can be created so quickly and can be very flexible to manipulate.

A conclusion can be made that the Empirical Modelling tools are really quick and effective on building up an interactive environment, and is ideal in research within the area of educational technology.

As in the title of this paper, this is a learning approach towards the science of Empirical Modelling and at this point I can only say that it is far from finished yet.

REFERENCES

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