

## New Zealand Society of Animal Production online archive

This paper is from the New Zealand Society for Animal Production online archive. NZSAP holds a regular annual conference in June or July each year for the presentation of technical and applied topics in animal production. NZSAP plays an important role as a forum fostering research in all areas of animal production including production systems, nutrition, meat science, animal welfare, wool science, animal breeding and genetics.

An invitation is extended to all those involved in the field of animal production to apply for membership of the New Zealand Society of Animal Production at our website [www.nzsap.org.nz](http://www.nzsap.org.nz)

[View All Proceedings](#)

[Next Conference](#)

[Join NZSAP](#)

The New Zealand Society of Animal Production in publishing the conference proceedings is engaged in disseminating information, not rendering professional advice or services. The views expressed herein do not necessarily represent the views of the New Zealand Society of Animal Production and the New Zealand Society of Animal Production expressly disclaims any form of liability with respect to anything done or omitted to be done in reliance upon the contents of these proceedings.

This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](http://creativecommons.org/licenses/by-nc-nd/4.0/).



You are free to:

**Share**— copy and redistribute the material in any medium or format

Under the following terms:

**Attribution** — You must give [appropriate credit](#), provide a link to the license, and [indicate if changes were made](#). You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

**NonCommercial** — You may not use the material for [commercial purposes](#).

**NoDerivatives** — If you [remix, transform, or build upon](#) the material, you may not distribute the modified material.

<http://creativecommons.org.nz/licences/licences-explained/>

# A MANAGEMENT INFORMATION SYSTEM FOR A BROILER HATCHERY

A. T. G. MCARTHUR

*Lincoln College, Canterbury*

D. K. LE PAGE

*Department of Agriculture, Christchurch*

## SUMMARY

This paper presents a generalized concept of an MIS and amplifies some of the main points with examples from the procedures used in a hatchery system. Details are given of some of the techniques adopted; some of the practical results from the use of the MIS are discussed, and suggestions made for further developments which could be applied to a total broiler system.

THE planning and control of organizations through the use of data has developed rapidly over recent years in business and industry because of developments in computers, statistical methods, and operations research techniques. The integration of these methods into a communication system for management to plan and control the organization has been dubbed the "Management Information System" (McRae, 1971).

An interest in communication and computers led the writers to build a very simple management information system (MIS) for a Christchurch broiler hatchery in order to gain experience in designing systems for agricultural situations. The development of the system originated from a request to computerize a forecasting calculation which the hatchery had been using. Figure 1 gives a brief description of the broiler operation under consideration.

The hatchery imports meat-producing stock from an Australian hatchery. There are two lines of imported grandparent stock which are multiplied up to produce parent stock. These lines are crossed to produce day-old chicks which are sent to contract growers. The contract growers form the only component in the system which is not part of the one company, though the growers are an integral part of the system. They buy feed from the mill and the cost of the day-old chicks is deducted from the returns for each batch of 8½-week-old broilers sent to the processing plant. The contract growers require 2.5 kg of feed for every kilogram of liveweight produced. The pro-

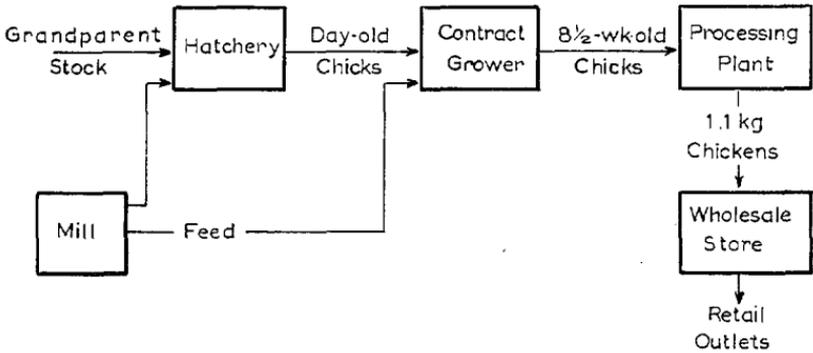


FIG. 1: Flow diagram of the broiler operation.

cessing plant produces 1.1 kg (2½ lb) frozen chickens which are sent to the wholesale store where they are kept under refrigeration until ordered by retail outlets.

The fact that nearly all the components are part of one organization means that there is considerable scope for the use of data to plan and control the production and marketing of broilers.

#### DESIGN CONCEPT OF AN MIS

An MIS is often thought of as a computerized approach for communicating with a data store. For example, the travel agent clerk types in the flight number to an on-line central computer and her terminal prints out the free space available. She then types in the passenger's name and this is stored on the computer's disc, the free space being reduced by one.

Though it is not essential, an MIS usually requires a computer. Two components are usually required beyond a data bank and a method of accessing it. These two components are the statistical bank and the model bank. Without these two components, the computerized MIS may overload the manager with information that may have very little practical significance to him for making decisions. Both computerized and non-computerized information systems have a reputation for this fault (Ackoff, 1967).

Figure 2 shows the MIS for the hatchery, based on the concepts of Montgomery and Urban (Montgomery, 1970). The design includes four internal components: A display

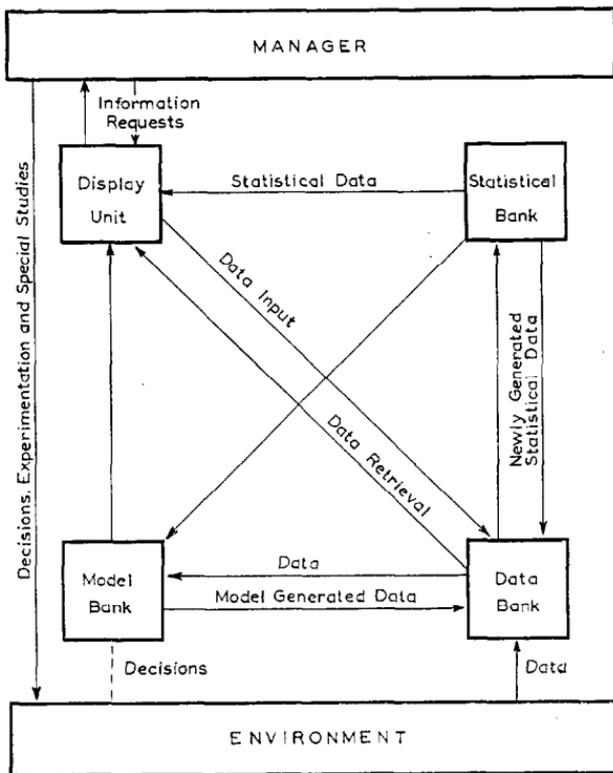


FIG. 2: An outline of a management information system.

unit, a data bank, a statistical bank, and a model bank, and is referred to by the authors as a decision-information system which interacts with two external components, the manager, and the environment.

The data bank provides the capacity to store and selectively retrieve data which result from monitoring the external environment. The data bank must also have the capacity to "clean" incoming data so that exceptional records are checked critically by management before being stored.

The raw data from the data bank may be displayed (via the display unit) directly to the manager, but to prevent data overload the manager will usually require data which have been analysed by statistical procedures. The procedures can vary in complexity from the simple estimation of means and standard deviations to multi-variate

analysis. These procedures are stored in the statistical bank. Newly generated parameters also can be stored back in the data bank (Fig. 2).

The model bank contains procedures for making decisions. The models, which represent the environment or some part of it, attempt to predict the outcome of a course of action. The model output results are displayed to the manager who makes a decision. A model for estimating the expected production of future daughters of a progeny-tested bull is a simple example. The model bank may also include routines for optimizing decisions. Simple decisions can be transmitted directly to the environment without going via the manager. Some feed mix problems can be set up as linear programming models and the results automatically transmitted into instructions for ordering and mixing.

Predictions from models must be checked against practical results and so model generated data must also be stored in the data bank (Fig. 2). Models are useful for determining data requirements and hence the all important connecting line between the manager and the environment representing requests for experiments and added data collection.

Information systems are dynamic. They grow and change as information technology and the environment change. However, the Montgomery and Urban design is useful because of the tendency for specialists to be more concerned with their own area (data storage, statistical method, operations research) without consideration of the system as a whole. Data which will never be of any use for making decisions are often collected. Complex statistical procedures are sometimes applied for their own sake, and models are designed without data. Thinking in terms of an information system gives an integrated approach to building an MIS.

#### THE HATCHERY MIS

The present hatchery MIS is a humble example but amplifies some of the main ideas in the Montgomery-Urban design. The hatchery consists of 8 sheds of laying birds. Their eggs are incubated in a plant with a capacity of 30,000 day-old chicks a week. A shed is stocked with 3,000 "point-of-lay" pullets and usually stays in production for 36 weeks. The shed has a minimum rest period of 3 weeks before starting another cycle.

The main elements of the information system are :

- (1) To monitor numbers of birds, egg-laying percentages, hatchability, and mortality. Records come in monthly to Lincoln College (data bank).
- (2) To make continuous estimates of the parameters for these variables (statistical bank).
- (3) To predict the total number of day-old chicks produced by the hatchery each week for a year ahead given the pattern of shed use decided on by the manager. This pattern is determined by the length of time the shed stays in production and the length of the rest period (model bank).

These jobs are done with a small 8K 1130 IBM computer.

If the predicted production is below the demand for day-old chicks, then the possible decisions the manager can make are: (a) Re-schedule the pattern of shed use; (b) Experiment with feeds, disease control etc. to raise production parameters; (c) Build more sheds.

Some techniques used in building this simple system follow.

#### CUSUM CONTROL

A forecast is calculated each month for each key variable (such as laying percentage) for the birds in each shed. If the actual egg-laying percentage has deviated significantly in one direction from the forecast level, then management should know. The deviation from forecast may indicate disease or feeding problems or simply errors in the records.

The cusum method keeps a running cumulative sum of deviations from forecast. If the system is out of control or the forecasting method is not adapting quickly enough, then the cumulative sum of deviations steadily increases. If the cusum exceeds a pre-defined limit, then a signal is sent to management to have a close look at the basic record and the forecast. The system operates according to the principle of "management by exception" both the forecast and the data being accepted unless the cusum control scheme indicates otherwise.

The calculation of simple cusum as applied to egg-laying percentages is shown in Table 1.

The great advantage of cusum methods for controlling forecasts based on past history is that the method is very sensitive to changes in the process.

TABLE 1: CALCULATION OF CUSUM FOR EGG-LAYING PERCENTAGES

<i>Month</i>	<i>Forecast</i>	<i>Actual</i>	<i>Error</i>	<i>Cusum</i>
1	50	47	-3	-3
2	48	41	-7	-10
3	46	40	-6	-16
4	44	38	-6	-24

Harrison and Davies (1964) have published a control scheme which can be operated with minimum demands on computer storage; the writers have adopted this scheme.

#### EXPONENTIALLY WEIGHTED MOVING AVERAGES

The exponentially weighted moving average is a convenient statistical method for routing forecasting (Winters, 1960) and has been applied to forecasting egg-laying percentages and hatchability for each month of lay. The basic procedure for each month is to calculate:

New forecast =  $(1 - \alpha)$  old forecast +  $\alpha$  actual.  $0 \leq \alpha \leq 1$

This simple forecasting system has three advantages.

First, it requires a minimum of storage space. In designing a data bank, the relationship between the cost of storage and speed of access has to be considered. It is cheap to keep data on cards but time-consuming to get at them. It is usually more expensive to keep the data on a disc but here they are quick to find. The hatchery MIS has basic data on cards and updated parameters on the disc. The new forecast just replaces the old forecast on the disc by applying the formula just given.

Secondly, using exponentially weighting moving averages means that all historical data contribute to the new forecast but the most recent data have the largest relative influence. The sensitivity of the forecast to current data can be adjusted by either choosing high values of  $\alpha$  (say, 0.3) for "nervous" forecasts which adjust rapidly to the current picture or low values of  $\alpha$  (say, 0.1) for "stable" forecasts which do not adjust so rapidly.

Thirdly, the correction for stage of lay can easily be incorporated into the forecasting system (see Winters, 1960).

The hatchery MIS also uses exponentially weighted moving averages to estimate the standard deviation of

forecasts for laying percentages and hatchability by a method recommended by Brown (1959):

New mean absolute deviation =  $(1 - \alpha)$  (Old mean absolute deviation) +  $\alpha$  (current deviation).

The standard deviation is equal to 1.25 times the absolute deviation—assuming that deviations are normally distributed. These standard deviation estimates make it possible to estimate the uncertainty associated with the predictions from the model.

### THE BASIC MODEL

The estimates derived continuously from these procedures are fed into a model for estimating the number of day-old chicks  $k$  weeks ahead for each shed. The predicted number of birds ( $N_k$ ) in a shed is,

$$N_k = N_0 e^{-rk}$$

where  $r$  is the death rate and  $N_0$  the number of birds in the shed now.

By applying the appropriate laying percentage and hatching percentage, the predicted number of day-old chicks for each week for the whole hatchery is rapidly calculated once a month—a calculation which was only done annually before computerization. The forecast runs a year ahead.

The variance of the prediction is also calculated using the standard deviation of the forecast errors, and combining the variances from several sources. It is hoped that uncertainty measures associated with the predictions will give some guide to the manager as to the risk he runs in his planning.

### MANAGERIAL RESPONSE

Since this program has been in operation, the laying percentages on the farm involved have been falling and the manager has perceived the extent to which they have dropped immediately. By comparing the output of the program with his original budgeted estimate, he can see the extent to which his production will fall later in the year compared with what he had anticipated.

Without the computer output, it is doubtful if the necessary hand calculations would have been done. The MIS output resulted in the manager making a quick diagnosis of declining laying percentage and an early assessment of the consequences.

The hatchery is now experimenting with different feeding techniques to improve the position. Any improvement will show up in the MIS as it occurs.

Because the program prints all output figures for each shed, the manager is able to use one or more sheds for trials and compare its output with the others to obtain an indication as to whether his changes have significantly raised or lowered laying percentage.

#### FUTURE POSSIBILITIES

Before suggesting more sophisticated possibilities for improving the MIS it should be made clear that setting up even such a simple system as this took considerable time (many of the problems arose from the small size of the computer and the "exceptions" associated with real farm-based data). While the broiler company could well attempt to extend the MIS to cover the operation of the broiler system as a whole, the quantity of programming and staff education required would be considerable. A large computer would also be needed. Such an extension would need to be gradual. Some future possibilities are:

- (1) An econometric model to analyse past sales and other economic data and to predict monthly sales up to a year ahead.
- (2) A production scheduling program to optimize the seasonal production of broilers, balancing the cost savings of level production against the costs of cool storing seasonal surpluses. This model would determine the best pattern of seasonal production.
- (3) A sales analysis to indicate marketing performance-and-possibilities for broilers.
- (4) A technical and economic analysis of the contract growers' operations to identify their problems early and provide a basis for negotiations.
- (5) A shed scheduling program for the hatchery to determine the optimum time for each shed to remain in production without re-stocking to meet annual production targets for day-old chicks through the year at minimum cost. Currently this planning is done by the manager. It could be done by computer with a better result.
- (6) A least-cost feed mix program combined with experimental evaluation for the feed mill.

- (7) Continuous budgeting and control of all the components of the system to check on profitability of the operation.

These suggestions for the development of the broiler MIS will require the collection, storage and statistical analysis of much more data. While this is a fertile field for the application of mathematical methods, initial experience confirms the wisdom of building a very simple MIS first for decisions which need to be made. Once confidence between manager and MIS grows, more can be added. This is a better approach than swamping management with an over-abundance of irrelevant information on computer printouts.

#### REFERENCES

- Ackoff, R. L., 1967: *Mgmt Sci.*, 14: 147.  
Brown, R. G., 1959: *Harv. Bus. Rev.*, July-Aug., p. 27.  
Harrison, P. J.; Davies, O. L., 1964: *Ops Res.*, 12: 325.  
McRae, T. W., 1971: *Management Information Systems*. Penguin.  
Montgomery, D. B., 1970: *J. Mktg Res.*, 7: 226.  
Winters, P. S., 1960: *Mgmt Sci.*, 6: 324.