THE INTERPRETATION OF DAIRY FARM DATA USING INTERACTIVE VISUALIZATION

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INTRODUCTION

Information has a major role to play in the day-to-day management of farms (van Asseldonk et al., 1999). This process can involve the combined analyses of economic, genetic and phenotypic data (with the last of these being categorised simply as management and environment). The limiting factor is usually not the amount of information, but rather its accessibility, its interpretation and its efficient use. The task of retrieving relevant information for analytical purposes can be quite frustrating for producers, given the abundance of different organisations that collect it, as well as the variety of devices (both on and off farm) that have the capability to capture it (Pietersma et al., 1998).

Information overload often leads not only to an inability to discover potential management aids but can even actively obscure them via overlapping, sometimes-contradictory data or simply the sheer number of ways in which they are presented to the producer and his/her advisors. The increasing availability of personal computers and the fact that the Internet is fast becoming a standard service, means that many new retrieval and management tools can now be investigated in ways that were not possible before. Management information systems have already been developed to provide information to support operations, management, and decision-making functions in an organisation (Huine et al., 1995). However, despite the design of many prototype applications, the utilisation of these technologies in management support systems is still low, compared with initial expectations and the technology's perceived potential (Hilhorst and Manders, 1995). This likely stems from such issues as client confidence in the system's reliability, a lacking in user-friendly interfaces and/or a need for training, and the generally narrow scope of the softwares in question (Hilhorst and Manders, 1995; Lozano-Fernandez and Flores-Cerda, 1998). Powerful computer resources and large amounts of data are not necessarily enough for progress to take place; for users to use these systems and be comfortable with them, they need the facility to explore the data, to communicate with the computer and to navigate the on-farm info-fog. Interactive visual computer-based systems have been developed with this in mind and represent an excellent opportunity to advance this aspect of information use.

INTERACTIVE VISUALIZATION

Human-computer interaction (HCI) constitutes an emerging field of research that aims at making information exchange between people and machine unconstrained and unambiguous, thus increasing the efficiency of these exchanges. Vision was the first sense to be associated with interactive systems because it has the largest bandwidth. Graphs and visual representations have long been used as an aid for viewing and interpreting data (e.g.,
statisticians frequently use graphs to find trends in data or relationships among variables. These kinds of visual aids can enhance our ability to understand data and help us to make better use of the information therein. With HCI, bi-directional communication between the user and the computer system allows for much more than, for example, conventional static graphs; it implies a real interaction with the possibility of modifying the view. The combined domain of data visualisation and interaction techniques has led to a deeper exploration of databases by users while also increasing the amount of (as well as the desire to) access these interactive computer-based systems (Shneiderman, 1994).

Visually interactive tools have proved efficient with regard to information retrieval and as data interpretation aids (Roth et al., 1996 ; Plaisant et al., 1999) and, even if most of these tools have been relatively specific in nature (application or information format), they were all designed with the aim of allowing managers to handle, interact and explore large amounts of abstract data in a visual and interactive environment. Management information is modified so as to turn static presentation into a so-called visualization. This process has an established methodology and follows a set of principles in the design of these information visualisation tools (Shneiderman, 1994). First, the tools must use visual interactive controls with outputs resulting from the user queries. Second, these (as well as any successive outputs) need to be produced rapidly, incremental in nature and reversible as needed. Finally, implementation and interaction are facilitated by the availability of many on-screen selections and mouse actions, thereby reducing the need to learn a new language or a large variety of specific commands.

![LifeLines for visualing patient records (Plaisant et al., 1999)](image_url)
Information visualisation techniques frequently begin by showing an overview of the complete data. The user can subsequently either "zoom" in on a particular section or filter/limit the information according to certain criteria. Specific details can usually be requested for a particular section. For example, Figure 1 shows an overview of a personal medical history (Plaisant et al., 1999). In order to trace problems more rapidly, the overall history highlights critical information or warnings by use of different sizes and colours. More detailed information is available on-demand by clicking on the appropriate event. The patient history remains on screen and serves as a context for the overall session, while specific details can be examined. Application classes, like these, that provide an overall setting along with rapid, incremental and reversible views of information, make for excellent candidates in dairy farming computer-based tools, given the diverse and varied sources of information that exist.

APPLICATION IN DAIRY FARMING

Dairy producers receive data and information from many off-farm organisations on a daily basis. These organisations include, among others, milk recording agencies, genetic evaluation centres, artificial insemination agencies, veterinarians and feed companies. Combining these off-farm databases with existing on-farm information (electrical devices, on-farm databases and even personal opinions and intuition) creates the so-called info-fog. The formats of these various data sources almost certainly differ, and there is usually no physical links among the off-farm organisations; everything passes to the dairy farm itself (where all reports are stored in one format or another). This is the kind of situation (dairy farm info-fog) where interactive visualisation can be especially useful – one that necessitates the development of a dynamic information retrieval system to improve the interpretation of data.

To this end, the querying of databases must be viewed as part of a larger work process, which also comprise the accessing and the analysis of data retrieved (a perceive-and-react loop). For example, the link between parental genetic evaluations and the growth performance of their progeny can be detected and studied at the farm-level using the appropriate combination of data and an effective visual representation. Moreover, interactive controls that select or filter a group of animals or view the data in a different manner, can enhance the exploratory and discovery aspects of the system.

A prototype management system has been designed to integrate different sources of heifer information and present them in a graphical environment (Infosys Group, 2001). It acts as a workspace that provides components that i) communicate with distributed sources of information; ii) retrieve information regarding one or multiple sectors of the farm; iii) organise it in a visual manner; and iv) provide users with controls that can explore it interactively. Figure 2 shows the sequence of events for the above management system whereby an overview of growth performance for all heifers in the herd is first shown. This is superimposed by the user's decision to select one heifer and a subsequent request to display genetic information for the heifer's sire and dam. This last task is facilitated by an agent that communicates with the remote genetic database to retrieve the requested information. This information can be kept, further filtered or discarded, according to the needs of the user at that particular time.
CONCLUSION

The paradox of multiple data sources means that, unless properly utilised, more information has the potential to hinder, rather than aid, the decision-making process. Interactive visualisation techniques seem promising for such an application. This approach is especially interesting in dairying where multiple reports and information sources tend to exist in an unorganised manner, and where profitable decision making depends on interpreting all of the inputs accurately. The process can be further enhanced by interactive visual representations of the information as well as the use of agents that can process various requests among databases.

REFERENCES


