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PROGENY EXPLORER: DESIRED GAINS IN PROGENY BASED ON EBVS OF CURRENT CANDIDATES

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SUMMARY
This paper presents a method for desired gains index construction. The method uses multiple-trait EBV's of candidates to explore the multi-dimensional surface of possible outcomes. An evolutionary algorithm is used to help find economic weightings that give results close to desired gains.
Keywords: Selection index, desired gains, TGRM.

INTRODUCTION
Setting the direction of genetic change is a key component of any breeding program. There are two approaches to doing this – the economically rational approach and the desired gains approach (e.g.. Kinghorn 1997). The economically rational approach is ideal where there is a strong knowledge about product value in the marketplace. However, some traits such as disease resistance can be difficult to evaluate, and the seedstock marketplace can be quite irrational. Under these conditions a desired gains approach, or a combination of both, may be more appropriate. A key problem with the desired gains approach is that initial desires in a specified direction will not be achievable in most cases. The program Desire has been written to discover the range of possible outcomes, and arrive at a theoretically achievable set of predicted responses, and economic weightings to target these (Kinghorn 2000a).

Desire is largely based on the approach of Brascamp (1984), which uses genetic parameters to handle predictions of selection response. This paper presents a different approach, which makes predictions based not on genetic parameters, but on the prevailing list of estimated breeding values of candidate animals for selection. This approach has been written into an application called "Progeny Explorer", named because it explores the possible range of outcomes in the progeny generation.

MATERIALS AND METHODS
Progeny Explorer uses the same data input file as used in the Total Genetic Resource Management (TGRM) system (eg. Kinghorn 2000b). This includes all estimated breeding values (EBVs) for traits of interest, as well as any limits on number of matings for each candidate animal. For any set of relative economic weightings on these traits, the optimal selection set (animals to be used as parents, and the number of matings per animal) can be found. Optimisation was carried out using a form of Differential Evolution, adapted from Price and Storn (1997).

Desire, shown in Figure 1, is largely based on the approach of Brascamp (1984), which uses genetic parameters to handle predictions of selection response *per generation*. In contrast, Progeny Explorer makes predictions *for the next progeny crop*, based not on genetic parameters, but on the prevailing list of estimated breeding values of candidate animals for selection. Predicted progeny merit is simply the average of parental EBVs, and there is no need to involve estimated genetic parameters.

RESULTS AND DISCUSSION

Desire helps the user to visualise the multi-dimensional response surface by providing 2-dimensional slices through this. The outer ellipses illustrate maximal responses achievable for each pair of traits, and the inner ellipses illustrate slices through the multi-dimensional space that adhere to constraints placed on other traits.

Notice that the ideally-shaped ellipses from Desire, based on predictions based on genetic parameters, are imperfect under Progeny Explorer. This is because they reflect responses in progeny that can be made with the exact candidates available for the current selection decision, and there is a finite number of parents available with an imperfect distribution of EBVs.

A degree of emphasis on desired gains needs to be declared. This is because with individual animal EBVs, desired gains are generally not exactly met, and very high emphasis on achieving desired gains will unacceptably compromise response in other traits. Placing more emphasis on desired gains in Figure 2 will make the inner constrained shapes even smaller and less regular. Given this, these inner shapes should be used as a guide only.

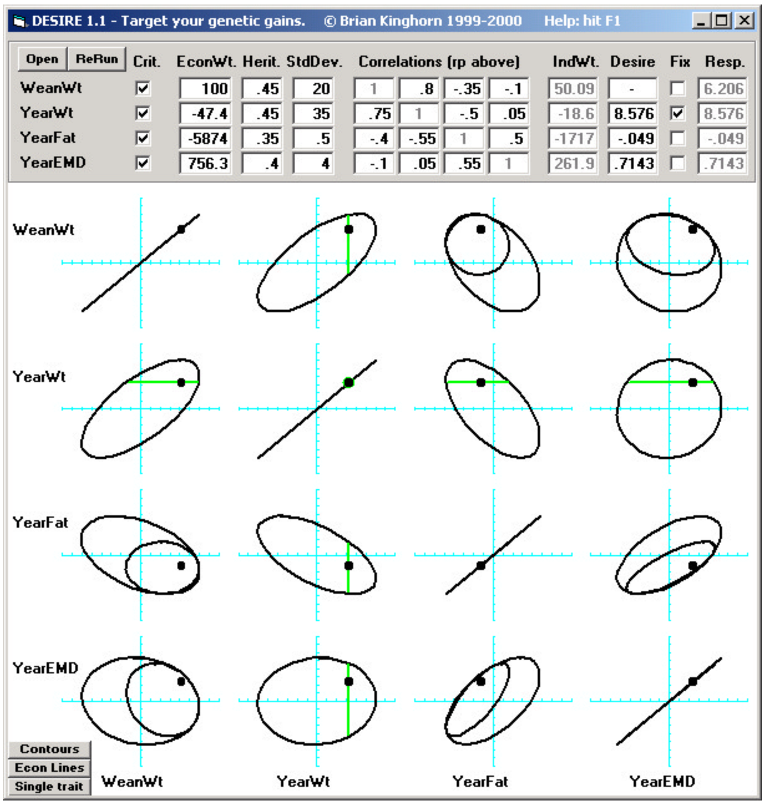

Figure 1. Screen capture from program DESIRE. The outer ellipses show limits of response for pairs of traits. "Fix"ing YearWt to +8.576Kg response constrains responses in other traits to within the inner ellipses. Parameter values were chosen for illustration only, to approximately match the pattern found in Figure 2.

Progeny Explorer should be used in conjunction with an economically rational tool such as BreedObject (Barwick and Henzell 1998). A planned feature is to show ranges of response that are constrained to expressing, for example, at least 95% of the predicted response under unadulterated use of an economically rational approach. This should be appealing to both 'rationalists' and 'free spirits', as the shape of response surfaces is such that there is usually quite a wide range of response directions possible within a few percent of theoretically maximum economic response.

Progeny Explorer will implemented as part of the TGRM system (Vagg *et al*. 1999), to help users set their overall breeding direction. Implied economic weights from Progeny Explorer can be used to calculate indices for selection candidates. This approach will help avoid current tendencies to manipulate selection direction through the means of predicted progeny genetic distributions in TGRM. These distributions should be used to influence variation and other distribution properties, as suggested in Figure 3.

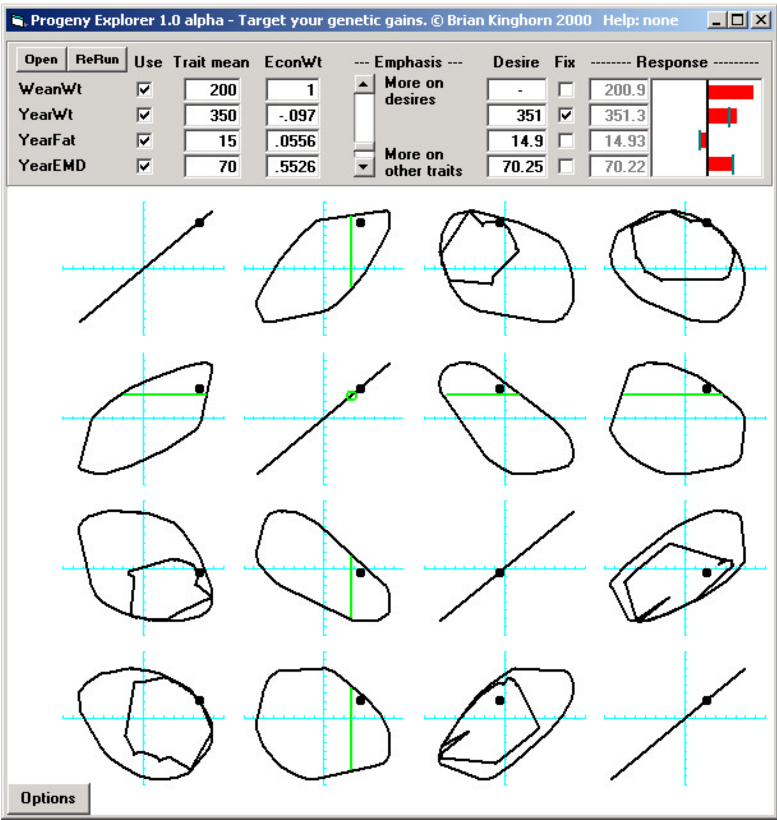

Figure 2. Screen capture from program Progeny Explorer. Inner ellipses especially are of irregular shape due to the vagaries of individual animal EBVs. Implied economic weights are relative to the first trait. Data for this example, other than trait means, come from an Australian beef cattle herd, courtesy of David Murray.

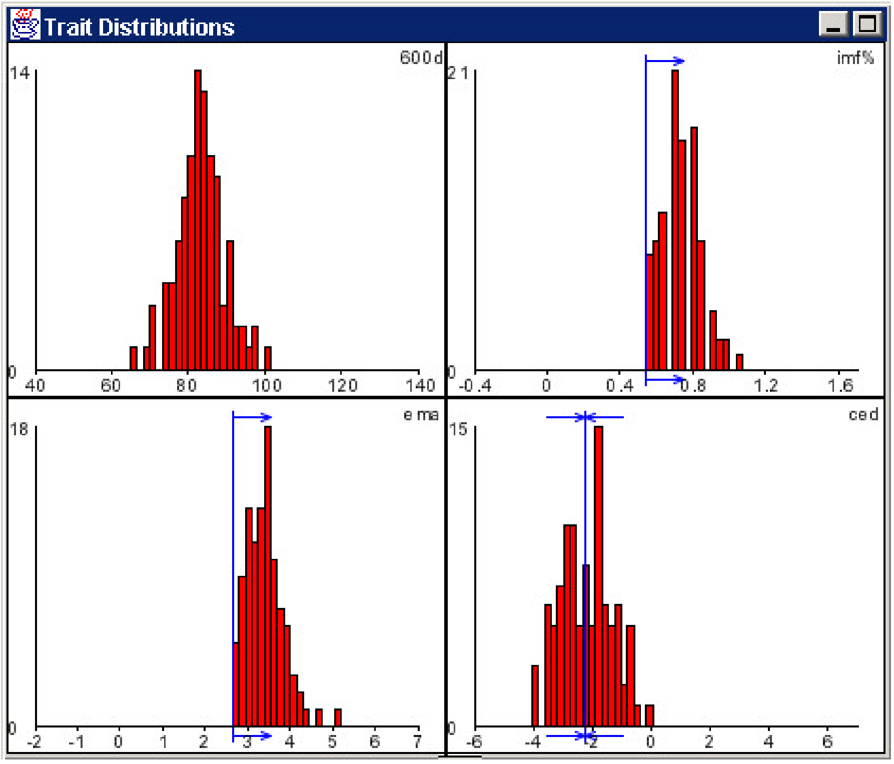

Figure 3. Trait Distributions window from TGRM Control Center, showing predicted genetic merits of prospective progeny from the current solution. This feature should be used to manipulate distribution properties other than the mean. Progeny Explorer is well suited to influencing means via implied economic weights.

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