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Biotechnology: Beauty or Beast ?

Kate UiGhallachoir and Clare Kavanagh

In recent years scientific advances have transformed that group of technologies referred to as biotechnology into a set of increasingly powerful tools for many industries. Biotechnology is identified by many as an important factor determining the future success of industries as diverse as healthcare and agriculture.

In Ireland biotechnology use and development is a recognised area of strategic priority. The research presented here investigates factors suggested as affecting the rate and direction of diffusion of new biotechnological techniques in the food and drink industry. It represents just part of more extensive ongoing research at the Dublin Institute of Technology, College of Marketing and Design, into the commercialisation of biotechnology based products.

At the International Symposium on Environmental Biotechnology at Ostend in April 1991, Olaf Diettrich used the metaphor of the beauty and the beast to describe the complex and tense relationship between the public and biotechnology. He pointed out the difficulty of identifying which is the beauty and which is the beast by posing the questions: "Is it the innocent and trusting public which is confronted with a pullulating science threatening human life, the environment and the integrity of God's creation? Or is it a pure and beneficial science promising progress in nearly all human problems which is rejected by an ignorant and distrustful public?"¹

The UK Advisory Council for Science and Technology (ACOST), define biotechnology as "a broad term to describe the production of innovative products, devices and organisms by exploitation of biological processes..."² From ancient times biotechnology has made a significant contribution to food production. It is through the application of those technologies labelled biotechnology that people throughout history have obtained wine from grapes, beer from barley and cheese from milk. In each case people provided conditions in which biological agents, i.e. bacteria, grew and worked upon the original material to produce something different.

'New' Biotechnology

In recent years, but especially since the late 1970s scientists have advanced their knowledge in regard to biotechnology. Their discoveries, particularly in relation to the possibilities for manipulation of the genetic material of living organisms, allow increased control over food production and other

disciplines such as medicine and waste disposal. The term biotechnology is now often used as a blanket expression to refer to work involving genetic manipulation. These so called 'new' biotechnological applications promise a wide range of food advances including leaner meat, enhanced flavour, quality and processing qualities of foods, more effective monitoring for possible microbial contamination in the current food supply and reduced pesticide usage on food crops. For instance, one product made possible through use of biotechnology is an extended shelf life tomato. Calgene, an American company, has produced this tomato through use of an antisense approach to regulation of gene expression. This involves cloning the gene of interest and transforming this gene into the plant in reverse orientation. Research continues on projects such as the possibility of producing sheep resistant to blowfly larvae through the introduction into sheep of a gene for chitinase. Chitinase is an enzyme found in tobacco, cucumber and other plants which attacks the cuticle of insect larvae. The researchers see no risk to human health should the sheep be eaten as "chitinase is already in your salad."³

The technologies offer benefits which are virtually indisputable. Yet the public is divided as to the merit of biotechnology use. Those opposed represent various positions across a spectrum of thought. Many are philosophically opposed to biotechnology. Additionally, opposition stems from environmental concerns of biotechnology use, concerns relating to the possible adverse social and economic effects of its application and to ethical and religious concerns. Industrial organisations however view science and thus biotechnol-

ogy as the engine of economic progress. Groups such as the European Senior Advisory Group on Biotechnology (SAGB) argue that "biotechnologies promise new opportunities for economic growth, new job creation, industrial renewal, environmental management and revitalised strength in the agricultural market place." They believe that "future European competitiveness on a par with the US and Japan in the many industries which will depend on biotechnology must therefore become the principal objective of Community policy."⁴

The conflict of attitudes towards biotechnological produced food is shown clearly by the current controversy regarding the use of recombinant bovine somatotropin or rbST, a synthetic bovine growth hormone. Commercial production of rbST has been made economically feasible since the discovery of recombinant DNA technology. This hormone can increase milk production from lactating cows by as much as 10-25% when injected. Reaction to possible approval and use of rbST ranges from total opposition as demonstrated by interest groups such as the Foundation on Economic Trends, a Washington based lobby organisation, to vigorous support from those involved with its development. The dairy industry is divided on the possibility of rbST approval and use. It is reported that the smaller dairy farmer tends to view the rbST development as a further step hastening the demise of the family farm, while the larger farmer looks forward to cost savings through its use. However, it has also been reported that of these larger farmers many continue to be concerned about the implications of use to animal health.

On the demand side research has highlighted consumer resistance to milk produced in this way. Research undertaken in the state of Wisconsin, where consumers are familiar with the concept of rbST, indicated that 71% were concerned about the possible ill health effects of milk from treated herds and 77% expressed a preference for milk labelled as coming from untreated herds.⁵ The reaction of the policy makers is predictably confused as they endeavour to satisfy the concerns of those opposed while at the same time encouraging the development of biotechnology. In the EC the result of attention to these dual responsibilities is a continuing moratorium until December 1993

thus prohibiting member states from authorising the administration of rbST.

Marketing Biotechnology Products

The lengthening delay to commercialisation of rbST serves as a reminder of the many conflicts which need to be addressed in order to develop and commercialise all biotechnology products. A critical strategic marketing issue to be addressed is that of consumer acceptance. The rate and direction of diffusion of new biotechnological techniques depends largely on consumer response to use of these technologies. Public perception issues are of particular importance to the food industry. Consumers are becoming increasingly discerning in regard to food choice. Integration of new biotechnological techniques into the food sector necessitates consumer acceptance of such modified products.

Research to date has indicated high levels of consumer concern about food produced through advanced biotechnological methods. Experience tells us however that all new technologies meet with an initial resistance. As yet it seems that many proponents of new biotechnology have approached public concerns as a 'communication' problem. Carol Tucker Foreman in her paper presented at the June 1990 council meeting of the National Agricultural Biotechnology Council in the US noted that often "there is an assumption that if the public can just be made understand, it will open its arms and receive biotechnology as an unmitigated blessing."⁶ This ignores the fact that even expert academic biotechnologists have often admitted diametrical views on the social risks and benefits of biotechnology. Also this concept of communication leans more to reassurance than to a two way communication channel, where the consumer has an opportunity to speak, to listen, to be heard, to act and to respond. It must be remembered that the problems associated with biotechnology might not be connected with communication but with conflicts of values which must be resolved in order to move forward. Explanations which Carol Tucker Foreman suggested for public rejection of biotechnology included the following.

- There exists considerable mistrust of scientific advances today. Consumers have learned from the experience of the 1950s when some products were

Table 1 Ranking of Food Safety Issues

1. Microbial Contamination
2. Nutritional Imbalance
3. Environmental Contaminants
4. Naturally-Occurring Toxicants
5. Pesticide Residue
6. Food Additives

Source: US Food and Drug Administration.

commercialised without adequate prior evaluation. As a result some consumers are concerned that gene technology foods, that is, those whose production or processing involves genetic manipulation, may also bring unannounced environmental or health risks.

- The public often opposes the introduction of new biotechnologically produced products because of factors unrelated to science. Economic and social factors, such as increased unemployment or rural depopulation, are also stumbling blocks as the rbST controversy remains proof.
- Consumers are becoming increasingly concerned with regard to information source credibility. The public appears to have lost confidence in the government institutions it once counted on to resolve questions of safety and conflicts between scientific, social and economic viewpoints.⁷ A study undertaken in 1991 which investigated European consumers' perceptions with regard to biotechnology indicated that the most reliable sources of information on biotechnology/genetic engineering are considered to be, respectively, consumer organisations, environmental organisations, and schools and universities.⁸

The problem of consumer misinformation has also been noted in relation to food safety concerns. In the mid 70s the Food and Drug Administration in the US developed a ranking of food safety priorities. Proportionally the ranking is depicted in Table 1 where 1 indicates greatest importance and 6 of little importance. Research indicates that the public inverts this table believing that the last three are major causes of human health problems.⁹

Problems associated with consumer misinformation point to the necessity for increased information to be available to the public about gene technology products. The more people are informed the more successful their decisions. However, the effect of information depends on its content, its selection, interpretation and/or rejection by the recipient. People generally accept or reject information on the basis of pre-existing attitudes, beliefs, values, experience, needs and perceived reliability or otherwise of the information source. Thus, even with increased information available, public resistance to biotechnologically produced

products may continue to exist. A view widespread in the food industry is that the challenge now is to reach a compromise on the issues of conflict if these new technologies are to be integrated into the food industry as in other industries while avoiding unintended and unpleasant consequences.

Biotechnology - the Infrastructure in Ireland

In 1987 biotechnology was identified by the Minister of Science and Technology as an area of strategic priority and the National Biotechnology Programme was developed. The primary aim of the programme is to commercialise biotechnology research in the universities and the research institutes. The coordinating body is BioResearch Ireland. Five university based research centres have been formed.

Two of these centres are concerned with food. These are the National Food Biotechnology Centre at University College Cork and the National Agricultural and Veterinary Biotechnology Centre at University College Dublin. In University College Cork research interests include the development of genetically engineered organisms for the enhancement of bio-processes, cheese and meat biotechnology and natural flavours. The work in University College Dublin focuses on plant and animal biotechnology. Incubation companies have been established on the different campuses and established companies have demonstrated their interest through involvement in cooperative research. This represents an important partnership between the industrial sector and academic institutions.

The importance of the food industry to the Irish economy should not be underestimated. It provides employment for almost 30% of those involved in Irish owned manufacturing and accounts for almost 20% of Irish exports.¹⁰ Recently a report on industrial policy for the 1990s highlighted this sector's potential for development, particularly in the context of primary food production and food processing.¹¹

Table 2 Sample

Consumer	28
Dairy	14
Brewing	4
Fish and meat	3
Bakery	3
Misc. general	4
Industrial/Supply	9
Ingredients	7
Animal and plant breeding	2
Total Sample	37

Biotechnology is identified as an increasingly important factor determining the future success of these sectors.

Public Perception of Biotechnology in Ireland

In Ireland research undertaken in December 1989 indicated that understanding of the term biotechnology is very limited among Irish adults. Only one in four have any spontaneous knowledge of the topic. Over half of all those interviewed had never heard of it and only one in ten felt they knew anything about it. Research did indicate a more positive than negative attitude towards biotechnology, and the more knowledgeable people were in the area the more positive their outlook. To a limited extent respondents recognised that biotechnology would play a more important role in the future than it does at present, and agriculture and health care were the areas of future potential impact identified.¹²

Research undertaken on behalf of the Directorate General, Science Research and Development of the European Commission indicated that, in a ranking of EC countries' objective knowledge of biotechnology, Ireland came ninth, that is, fourth from the bottom. Using an index of objective knowledge score where seven is complete knowledge and zero is no knowledge, Irish respondents scored a mean of 3.56. Irish respondents also indicated high levels of support for biotechnology research.¹³ It is against this backdrop of knowledge that we must view the results of this study.

The Primary Research

The research presented here is part of more extensive ongoing research into the strategic issues associated with the commercialisation of biotechnology based products and services being conducted at the Dublin Institute of Technology, College of Marketing and Design. The objective of this research was to investigate Irish food and drink firms' attitudes towards the possible use of new

biotechnological techniques in their industry. Particular attention was given to the exploration of their beliefs in regard to the importance of public perception issues on their plans for the future.

Methodology

The study was undertaken through use of structured telephone interview with a sample of 37 leading food and drink firms. Firms chosen were potential or actual early adoptors of new biotechnological techniques and included established firms in addition to emerging firms established to exploit the new technologies.

As the use of advanced biotechnological techniques is a relatively new phenomenon with regard to food and drink production, it may be realistically assumed that few, if any, Irish firms have as yet adopted these techniques. New technology adoptors tend to be larger firms, involved in high levels of research and development. In order to assess the opinions of early adoptors and of those firms most likely to adopt these techniques in the near future, the sample chosen included two distinct groups of firms. The first group had shown an interest in new biotechnological techniques thus identifying themselves as potential adoptors. The second consisted of firms which had shown no interest to date in these techniques but which were identified by the researchers as possible future adoptors. Firms identified by the researchers for selection into this second group were larger firms with interests in research and development. Academic institutions were not included in sample although it is acknowledged that new technologies tend to be first adopted in sheltered or campus companies.

The sample was purposive and was chosen through use of three lists. The lists were used to identify companies interested in or involved with new biotechnological techniques and also the largest food and drink companies in terms of turnover. The lists were:

1. Coombs, J. and Alston, Y.R. (1991), *International Biotechnology Directory 1991 - Products, Companies, Research and Organisations*, Macmillan, London. (This directory lists companies from all over the world with interests in biotechnology).

2. Participants in the LABIP conference, Cork, May 1992. (Organised under the auspices of Biotechnology Research for Innovation, Development and Growth in Europe (BRIDGE), the Lactic Acid Bacteria Industry Platform offers a forum for exchange of views in relation to biotechnology in lactic acid bacteria research. This conference was attended by biotechnology experts from both industry and academic sectors).

3. *Aspect* - top 1200 companies. (Companies listed in order of turnover).

Firms were selected in accordance with two sample controls. First, in order to investigate fully the impact public perception issues have on companies considering adoption of new biotechnological techniques, it was decided to bias the sample in favour of front line consumer firms. 28 consumer firms were included in the sample and 9 industrial or supply firms; thus front line consumer firms were represented in the sample in a ratio of 3:1 to industrial/supply firms. Second, it has been suggested that the application of new biotechnological techniques offers significant potential for the dairy sector.¹⁴ Due to the importance of this sector in the food and drink industry it was decided thus to represent dairy firms as 50% of all front line consumer firms.

In choosing the sample the researchers' objective was to obtain a proxy census of actual and potential early adoptors of new biotechnological techniques within the food and drink sector. The sample size thus was dictated by the level of interest in new biotechnological techniques. The sample controls reflected the trends of interest existing in the food and drink industry and facilitated correct selection of potential early adoptors. The sample was divided in the manner set out in Table 2. The sampling unit was the individual food and drink company. One response was sought from each company either from the Research and Development Director, the Technical Manager or the Quality Control Manager. Results were analysed using a qualitative approach. A response rate of 73% was recorded and the interviews were undertaken during November 1992.

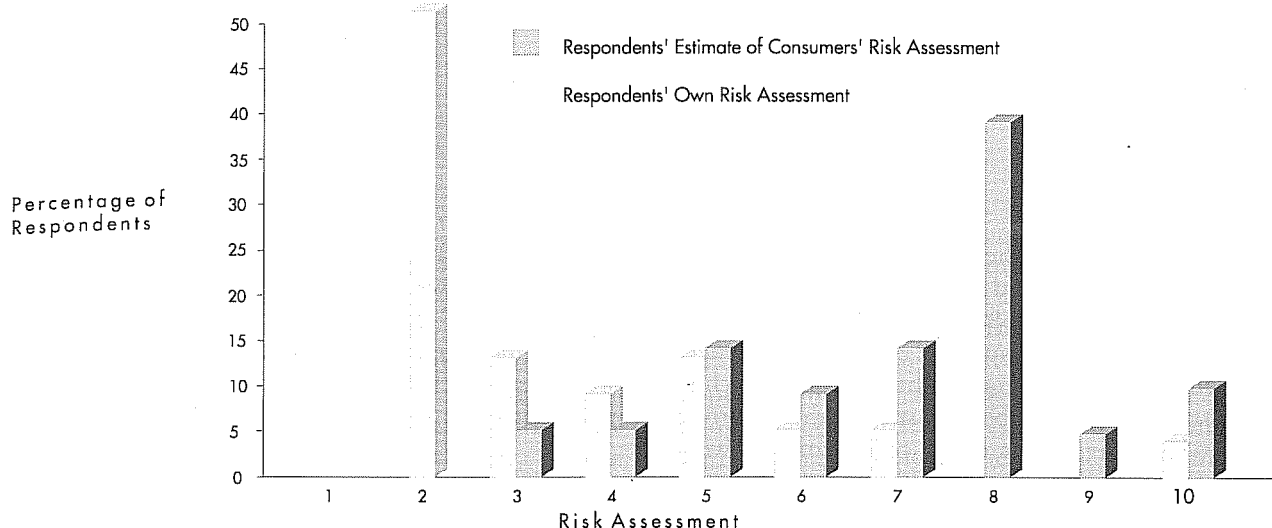
Findings

The results of the study indicate that consumer resistance to food produced through advanced biotechnological methods is anticipated by most

experts working in the Irish food and drink industry. This anticipated resistance is viewed as the greatest barrier to continued and future use of advanced biotechnological techniques. Respondents tended to support educational measures to combat possible adverse reaction and 59% favoured labelling of gene technology foods. The majority of those surveyed asserted that advanced biotechnological techniques will have an impact on their industry, but futuristically, that is, well after the year 2000. They identified the dairy sector as the sector of greatest potential impact. 59% of those surveyed stated that they could envisage becoming involved with these techniques in the future. In summary, while public perception issues were recognised as important, it may be stated that for most respondents anticipated consumer resistance to gene technology foods is not perceived as an insurmountable problem. The findings of each individual question asked are now presented.

Barriers to Continued and Future Use

The salience of the issue of consumer perception of gene technology foods to those surveyed working in the food and drink industry was clearly indicated by the findings of this study. In response to the question, "In terms of the barriers preventing the continued and future use of genetically engineered food and drink what for you would be the most important barriers?", 51% of respondents answered consumer resistance. Another 21%, who suggested the regulatory environment as a barrier to continued and future use, discussed this factor as a problem in so far as it related to the possibility of labelling directives. Respondents felt that if products were labelled as being genetically manipulated then consumers might not accept them. However, a distinction was suggested in the findings between the opinions of those companies involved directly with consumers and those not. The possibility of consumer resistance was only mentioned as a barrier by one non-consumer firm as opposed to seventeen of those involved with consumers. The most frequently mentioned barrier to use for those without direct consumer involvement was the perceived lack of tangible benefits for the manufacturer inherent in the techniques. The point was made that the firms would not adopt the techniques unless they offered a cost saving or other such benefit. One respondent summed up the

Table 3 Respondents' Risk Assessment

feeling by asserting "they (biotechnological techniques) will not be adopted for the sake of it..."

Risk Assessments

Respondents were asked to indicate on a scale of 1 to 10 (with 1 = no risk, up to 10 = very high risk) both their own numerical risk assessment of food and drink produced through advanced biotechnological techniques including genetic engineering and that of consumers. Two firms uninvolved with consumers refused to give a risk assessment on the grounds that each new food would necessitate individual assessment. However the results show a consensus emerging among those who did respond. All save two estimated the consumers' risk assessment as higher than their own. Risk assessment scores are set out in Table 3. Respondents' more usual numerical risk assessment of food and drink produced through advanced biotechnological methods was 2 (low risk), and their estimate of the consumers' risk assessment was 8 (high risk). The findings here further support the argument that experts working in the food and drink industry anticipate adverse consumer reaction to gene technology food and drinks.

Consumer Reaction

The findings indicate almost complete agreement among those interviewed as to the expected adverse reaction consumers will have to genetically engineered food and drink. Six experts however did not anticipate an adverse reaction and their opinions were variously:

"If the customer is ok (following consumption) then the response will be ok... it will find its place"

"Consumer reaction is lead by press reaction..."

"If it's cheap enough they will eat it"

Due to the overwhelming response indicating an expected negative consumer response some of the comments are presented.

"Brutal"

"With doubt"

"Conservatively"

"Slow to accept... traditional consumers"

"With confusion"

"Strong bias against initially... if realised"

"Ignorance... sceptical"

"Poorly"

"Badly"

"Cautiously"

"Hard to say... adverse reaction"

"Badly... lack of understanding... Genetic engineering whips up emotion, but if explained... no difficulty"

"Consumer might not realise, additives might be a bigger problem... wary, this is a worldwide phenomenon"

"Unless parcelled properly... will find objection"

"Not great" (sarcastically)

Consumer Reaction Remedy

60% of those interviewed suggested education as a remedy to possible adverse consumer reaction, although 23% focused on particular aspects of consumer education such as balanced media debates, proof of safety and communication of this proof, in addition to highlighting the importance of food and drink companies becoming more open about their development activities. It is noteworthy that two respondents felt that the situation could not be remedied through education. Rather they felt the techniques should be dropped. Also, another two respondents, notably from the supply sample, felt that adverse reaction had not been noted and should not be expected. As one respondent asserted, "if it's not broken don't fix it..."

Labelling

Respondents were divided in their opinions as to whether genetically engineered food and drink should be labelled. Although 26% of respondents, representing the largest response category, favoured labelling as a consumer right, reasons were given in support of non-labelling, such as the assertion that labelling might cause confusion among customers. If those in favour are compared with those opposed, disregarding the 'don't knows', the figures favour labelling (59% as opposed to 33%).

Further analysis indicated that those companies in the sample who had evidenced an interest in or involvement with biotechnological techniques, compared to those who had not to date, were most likely to feel labelling of genetically engineered goods a consumer right. In total, 85% of those firms which had shown an interest in new biotechnological techniques were in favour of labelling, if for different reasons. However, the opinions of those who had not evidenced an interest in such techniques were more dispersed (43% opposed labelling; 49% were in favour, and 8% gave no opinion).

With regard to the regulatory environment generally governing the use of new biotechnological techniques, the results highlighted a level of indifference. 58% of those interviewed either hadn't sufficient knowledge about the regulations to make an assessment, felt the regulations were not relevant to their activities and to the general activities of firms in the food and drink sector or had no comment. The common perception among those interviewed was that the regulatory environment governing the development and use of new biotechnological techniques was irrelevant to their work and involvement with biotechnology. In interview, it was perceived that those who expressed an opinion on whether the regulations encouraged or discouraged work shared this view. It may be inferred thus from these findings that use of new biotechnological techniques is limited among Irish food and drink firms.

Impact of New Biotechnological Techniques

Respondents opinions were also explored with regard to the impact they anticipated advanced biotechnological techniques might have on their industry; the food and drink sector of greatest

potential impact, and their thoughts or plans on becoming involved in the future. Again the results of this investigation shows a clear distinction between those firms in the sample which had evidenced an interest in or involvement with these techniques and those which had not. Taking the former companies first, the results showed the following.

- The majority of these firms feel that advanced biotechnological techniques will have an impact on their industry, but futuristically, well after the year 2000.
- These firms identified the dairy sector as the sector of greatest potential impact.
- Only three of the thirteen ruled out the possibility of becoming involved with these techniques in the future and nine asserted that they could envisage becoming involved or would become involved in the future, with only one "don't know".

The results from those companies which were identified as potential adoptors but had not evidenced any interest in or involvement with the techniques to date were quite different. Among these respondents no consensus was reached as to the probable impact of these techniques on the food and drink sector. Four respondents admitted to not having sufficient information to make an assessment and the opinions of the rest spanned the poles of no impact to major impact. With regard to the sector of greatest impact, again no consensus was reached and the respondents mentioned all sectors save, bakery, fish and meat, in equal proportions. In terms of their intention to adopt the techniques in the future, four asserted that they definitely would not adopt, seven 'yes', and three 'don't know'.

If one assumes that those who have evidenced interest or involvement are the most knowledgeable, it would seem that the informed view in the food and drink sector is that new biotechnological techniques will have an impact on this sector but futuristically, post 2000, and that the sector of greatest potential impact is that of the dairy sector. On the issue of future adoption the experts are divided, but 69% of the most informed could envisage a scenario presenting itself where they would become involved.

Conclusion

The research presented here represents part of more extensive ongoing research at the Dublin Institute of Technology, College of Marketing and Design into the commercialisation of biotechnology based products. Ireland has a well developed infrastructure aimed at supporting biotechnology based industries. As an integral part of this infrastructure strong links have been established between the academy and industry.

As noted, most recent studies indicate the existence among Irish consumers of a more positive than negative attitude towards the use of advanced biotechnological techniques. The research presented here however highlights the anticipation of adverse consumer reaction among those working in the food and drink industry to biotechnology applications in their sector and to the resultant products. The expectation of consumer resistance

is reasonable if one examines the experiences of those who have introduced gene technology foods in other markets. The problems of rbST commercialisation remains a case in point. For Irish firms considering involvement with these technologies, consumer attitudes would seem favourable. The research indicates that to date the use of new biotechnological techniques in the food and drink is very limited. However, the benefits of use must be weighed against the consequences of possible consumer backlash in any decision on involvement. Also opposition to the use of biotechnology is becoming more apparent as public interest groups gain support and power. Biotechnology and its applications are not the focus of vociferous public debate in Ireland as in many other European countries, notably Germany and Denmark. The importance of the food and drink industry to the economy requires that individual firms make a favourable decision on this issue for success in home and international markets.

Authors

Kate UiGhallachoir is a Lecturer in Marketing at the Dublin Institute of Technology, College of Marketing and Design, and is leading research at the college on the marketing of innovative technologies with specific reference to biotechnology. This research is part funded by Eolas.

Clare Kavanagh is a graduate of the College of Marketing and Design and is currently undertaking postgraduate research in the college under the ESF Strategic Research and Development Programme.

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