Economic Perspective 3

NEW TECHNOLOGY AND STEEL PRODUCTION

by David N F Bell, University of Stirling,
Jeanette Findlay and Christine Oughton,
University of Glasgow

1.1 Introduction

This paper is a response to a review of our report Steel Production in Scotland: Strategic Considerations for the 1990's.[1] The report was commissioned by Strathclyde Regional Council at a time when British Steel (BS) was known to be reviewing its long term strategy for the production of steel plate. Then, as now, BS's plate production was concentrated at two sites, the Dalzell plate mill in Scotland and the Scunthorpe mill in England. It was well known that one of the main strategies under consideration by BS was the 'single plate mill strategy', which as its name suggests, entails concentration of plate production at a single site. Our brief was to examine the economic case for maintaining, and investing in, plate production in Scotland.

Subsequently, a review of our report written by J Love and J Stevens (LS) of Strathclyde University appeared in the Fraser of Allander Institute Quarterly Economic Commentary.[2] The main conclusions of the LS review were as follows. First, although they agree with many of the main conclusions of our report, they argue that our evidence is insufficient to support these conclusions. In particular, they claim that:

(i) in order to make a case for siting a single plate mill in Scotland, it is first necessary to justify steel production in Scotland;

(ii) that we have explicitly ignored new technological developments which are on the horizon and which will have a significant effect on BS's strategy, and

(iii) that such new technological developments favour the development of mini-mills at Hunterston rather than continued production in Lanarkshire.

This article discusses each of these issues in turn. The following section deals with the charge of 'insufficient evidence'. Section three considers LS's claims about new technology and their suggestion that BS should invest in mini-mills at Hunterston. Section four contains a summary and our main conclusions. Finally, an appendix to this paper lists a number of factual corrections to inaccurate and/or incorrect statements made in the LS review.

2.1 Evidence/Analysis

The most general criticism which LS make of the report is that a number of conclusions are not supported by sufficient evidence or analysis. However, in many of the instances to which they refer they neither disagree with the conclusion in question nor do they suggest in which way the supporting arguments or evidence are deficient. In consequence, it is not always clear precisely what would be required by way of evidence. Since they themselves agree with us on many of these conclusions, we must assume that LS are aware of stronger evidence and are intending to publish it at some stage. We would welcome such a publication.

One example of this is their review of the section of our report which questioned the recent investment policy of BS. We suggested that it was hard to justify the policy of BS to under-invest in the Scottish plants on economic grounds. LS agreed with our supporting arguments on this issue. However they argue that 'these points in themselves are not sufficient to justify the above assertion' but they also state that 'there is a case to answer'. They then proceed to explain why it was correct for BS to develop the Port Talbot and Llanwern plants at the expense of Ravenscraig. Their argument can be summarised as follows: after the 'introduction in February 1980 of the EEC's

code on state aid....which dictated that investment subsidies would only be authorised on the basis of clear programmes to restructure and reduce capacity' BS decided to modernise the Welsh plants and reduce capacity elsewhere. In consequence, the Port Talbot strip mill was modernised, and this gave BS justification to 'modernise and construct strip finishing and processing facilities in Wales' and presumably set in motion the dynamic which is now leading to centralisation of facilities in Wales and consequent marginalisation of the Scottish plants. LS go on to argue that "After the Port Talbot decision, we would strongly refute any suggestion that BSC's investments could not be vindicated on the basis of a fair appraisal..." (p 66). There are two points here.

The first is that this line of argument does not address the central question of why BS took the decision at that time to concentrate investment in Wales and capacity reduction in Scotland. There is nothing in the LS review which answers that question and the geographical pattern of BS's past investment policy still remains unexplained. The second point concerns the role of investment appraisal. The Monopolies and Mergers Commission's 1988 report on the efficiency of the British Steel Corporation found that BSC's investment appraisal was 'not sufficiently systematic' and did not 'explore a range of options'. Moreover, the main recommendations contained in the report suggest that BSC should undertake more systematic investment appraisal. Since BS's investment programme was not based on systematic appraisal of all options it is difficult to know how LS, who have not presented any empirical evidence to support their claim, can conclude that BSC's investment programme would be 'vindicated on the basis of a fair appraisal.'

Of course, once investment is centralised at a particular site, that in itself might justify future investment in that site or, at least, might partially justify closures being concentrated in other sites. While we agree with LS when they state that the decision to upgrade the Welsh plants made the argument for Ravenscraig more difficult, it is not the case that this would be the only factor which should be considered in a systematic appraisal of investment projects. LS, in explaining the investment decision of BS, following the upgrading of Port Talbot argue that

"..a similar throughput can be produced at lower unit cost by transferring production from Scotland." (p 66)

The authors give no evidence for this assertion and indeed, BS are the only party able to confirm its veracity. However, BS have never released the necessary data to allow independent calculation of unit costs across the five sites. Further, it is clearly important to know not only which are the lowest cost sites, but by how much costs at these sites undercut those elsewhere. None of this information has ever been made available by BS.

LS argue that our report failed to take account of the impending costs of rebuilding coke ovens and relining blast furnaces at Ravenscraig (p. 66). While such renovation will indeed be necessary at Ravenscraig similar procedures will also have to be undertaken at Port Talbot and Llanwern at some point in the future. Which, if any, of these costs should be taken into account when considering plate-mill strategy depends on the time-horizon used to appraise the investment plans. As the horizon extends, technological uncertainty makes such calculations fraught with difficulty. Paradoxically, LS argue that developments in the technology of iron-making may render coke-ovens and blast-furnaces redundant.

The second major conclusion which LS find unsupported in our report refers to our contention that BS shareholders would be best served by siting a single plate-mill in Scotland. LS accept that the Dalzell mill compares favourable with other European mills in terms of product range and quality. They accept the figures we give for the cost of upgrading the Dalzell mill. They accept that the cost of building a new mill at either Lackenby or Scunthorpe would be more expensive than a similar project at Ravenscraig. They accept that our refutation of the 'ageing mill' argument propagated by BS is 'both cogent and well-directed' (p 67). They raise a question of constraints placed upon the product range by the overland transport system. However, they fail to specify the nature of the constraints or to specify in which way this constraint is different from that faced in the alternative sites. We are therefore unable to address this point. Hence, LS, with one unspecified exception, accept all our major arguments. However, they do not accept our conclusion. The reason they give for this is that the '..plate mill decision has not been placed in its proper context" (p 67). They go on to say that 'a critical deficiency is that the report

fails to demonstrate conclusively that BS will need Ravenscraig's steel output' (p 67). This point will be dealt with in our response to the second main criticism which LS make of the report, namely, the arguments surrounding new technology.

Finally, LS argue that our report does not show that a refurbishment of the Dalzell mill would be a better option than refurbishing the existing mill at Scunthorpe. They accept our assessment that the costs of refurbishment are less at Dalzell than at Scunthorpe, but they suggest that the Scunthorpe option would involve energy savings and lower transport costs. While the point about energy savings is valid - we refer to it in our report (p 23) - the point about lower transport costs is at the very least debatable. LS give no evidence whatsoever for this assertion and it is at odds with the fact that Scunthorpe is not a coastal site. Moreover, the port facilities at Immingham are the worst of all of BS's sites. For example, the draught at Immingham is less than half that of Hunterston, hence, the possibilities for exploiting economies of scale in shipping are significantly less than those at Ravenscraig.

The contention that our report fails to give a proper comparison of costs between the possible options available is incorrect. On pages 22 to 26 of our report we give a detailed assessment of all the costings for each option including the Scunthorpe option and we refer the reader to that section. We reject the assertions that we have assumed '..invalidly that a supply of slabs from nearby Ravenscraig will be costlessly available over the time horizon of the project' (p. 70). At no point in our report have we said this nor did we assume it. It is not implicit in any of our conclusions and LS have not demonstrated that it is. The absolute cost of slabs coming from Ravenscraig is, in fact, irrelevant. What matters is the relative cost of slabs supplied from different steelworks to potential plate-mill sites. Even if such costs were found to be relatively high at Ravenscraig, which does not appear to be the case, it is our view that they would be outweighed by the higher capital costs associated with the other potential sites.

2.2 Ravenscraig/Dalzell

It is our view that the future of both Ravenscraig and Dalzell are closely linked. Thus the argument for siting a single plate-mill in Scotland is partially based on the existence of an adjacent source of high-quality slab. While at the same time, part of the argument for maintaining steel production in Scotland at Ravenscraig is dependent on the existence of a market for its output. At the moment around 25% of its output goes to Dalzell and presumably a larger proportion of its output would go to a single plate-mill which would require a larger input of slab.

The attempt by LS to construct a case around the idea that you must first justify basic steel production in Scotland and only then can you start to make a case for siting a single plate-mill in Scotland does not seem to accord with what one would typically understand to be the policy of a large steel producer. Our understanding is that the main concern of BS is to make profits. Profits arise from the sale of the final product which in this case is steel plate. Integrated steel producers will seek a manufacturing process which makes products which meet customers' specification at lowest cost.

In the long-run, this would imply that each part of the production process, from basic steel-making to rolling plate is fully efficient. However, long-run efficiency in the steel industry is a moving-target as technologies and cost conditions change. Further, companies are wary of fully committing themselves to wholly new production structures because of the enormous capital costs which they will incur. In practice, this means that production processes are developed in a piece-meal fashion and that producers are generally aiming at short-run rather than long-run profit maximisation. However, the time required to plan and build steel plants, implies that the long-run in the steel industry can be a very long time indeed and that investment policies tend to be based on existing plant configurations. It is very difficult for an established producer to start from a 'clean slate'. Instead, starting from a given capital configuration, a short-term profit maximising strategy may mean that some parts of the process are inefficient in the sense of being more costly than the most efficient alternative available. This does not justify the abandonment of the entire process unless its other components are also inefficient. Rather, it suggests a piecemeal approach where different parts of the process (eg basic steel-making) are replaced at different times. Thus the argument that somehow basic steel-making at Ravenscraig must be justified in isolation before any consideration is given to plate does not seem to

follow: BS undoubtedly takes into account its existing plant configuration when making new investment decisions.

2.3 Demand Prospects

LS correctly identify demand prospects as a key issue in making a case for continuation of production at Ravenscraig. In this respect they argue:

"In our view, the Report fails to provide a sufficiently detailed discussion of the evolution of either UK steel demand or the demand for BS's product range." (p 67).

In fact, the report contained a detailed summary of steel demand drawn from a number of sources ie ECSC, the Royal Bank and our own survey of steel users. The results from the latter are referred to at various points in the report, despite the statement by LS to the contrary. We have subsequently conducted a further survey of oil companies which shows that demand from the North Sea industry is buoyant.

The demand forecasts given in the report are broken down into a number of sectors. The results are not explicitly given in terms of product range, however, forecasts for coated and quality steels are given and demand in terms of product range can be inferred from knowledge of the sector from which it emanates. For instance, it is mentioned in the section on demand from oil companies, that development expenditure figures are, for the most part, made up of demand for plate.

In addition, it was not the remit of our study to look in detail at demand for all types of steel. As we have already mentioned we were asked to concentrate on plate. In the interests of conciseness and bearing in mind the time constraints we were working to we maintain that we presented sufficient evidence to support any conclusions which we drew. We would not, of course, argue that we presented the final word on the matter and would welcome any further work in this area.

2.4 Imports/Import Substitution

In relation to our discussion of possible areas of future demand, LS agree with the following points,

"Demand prospects are favourable. The UK market has been subject to increasing import penetration and BS increasingly commands a smaller proportion of its home market. In recent years, the average value per tonne of UK imports has been greater than the average value per tonne of UK exports." (p 67)

They go on to say

"It is our contention that the researchers set out this data to imply that there are profitable markets both at home and abroad which BS could serve and thus increase the probability that it will require its Scottish operation. If this is the motive, then it is our view than (sic) further analysis is both needed and warranted to substantiate this point." (p 67).

It was indeed our intention to make this implication. The very fact that foreign steel-makers are making increasing inroads into the domestic market of one of the most efficient steel-producers in Europe indicates that BS could expand production to regain its market share. However, LS argue that BS is acting like a text-book monopolist ie restricting output and keeping prices high.

"..BS has recently announced price rises across much of the flat product range at a time of on-going production pauses in Community markets. Whilst this will protect margins, it will facilitate greater import penetration and check the rate of export growth....This behaviour illustrates that the level of production can be manipulated by BS and that it is profit and not output which will be maximised in the coming decade. (p. 68)

This interpretation is a distinct possibility and must be assessed together with BS's claims that it is restricting output because of insufficient demand at a viable price.

3.1 The Impact of New Technology?

Despite the fact that our report contained a fairly detailed discussion of best practice techniques in plate making and finishing, Love and Steven's argue that,

"a second major criticism of the Glasgow study pertains to the short sighted and invalid

treatment of the technological issue."

The LS review has little to say about plate making technology itself, but it argues that two upstream technological developments - thin slab casting and direct smelting - are relevant to the plate mill decision. Since LS do not provide a detailed assessment of the impact of these technologies on large integrated steel production we discuss the nature of these two technologies and their likely role in future steel production.

3.1.1 Thin Slab Casting

Thin slab (or near net shape) casting is a new type of continuous casting process that produces thin slabs around 2 inches thick. The advantage of this process is that thin slabs require less hot rolling to produce hot rolled coil. At present, six thin slab casters have been installed across the USA and Europe but only three of these are beyond the testing stage and none of them is producing their specified capacity.[3] The leading company in this field is the Nucor Corporation based in the USA. The thin slab caster installed in Nucor's Crawfordshire site is based on the SMS process and has recently (June 1990) reached break-even production levels of 32,000 tonnes per month (around 400,000 tonnes per year (tpy)) out of its full potential capacity of 800,000 tpy. Nucor expect to reach specified production capacity of 660,000 tpy by December 1990.

It can be seen that world-wide there have only been two months of profitable production based on thin slab casting and that the technology is very much in its infancy. Nevertheless, all the indications are that thin slab casting is a major technological process innovation that will eventually replace conventional casting, at least for the production of strip products. The important question is: how long will it take for the technology to diffuse from the mini-mills, who have a history of being the first to introduce new techniques, to large scale integrated plants? It is, of course, difficult to answer this question but some light can be shed on the issue by considering the diffusion time for conventional continuous casting. The first continuous casters were installed in the 1950's. By 1980 continuous casting accounted for about 25 per cent of world steel production and by 1990 the proportion of steel produced by continuous casting was 84.2 per cent in Europe, 93 per cent in Japan and about 60 per cent world wide.[4] Although, it might be reasonable to expect that the diffusion time of thin slab casting will be less than that of conventional continuous casting, LS's claim that this technology is relevant for BS's current plate mill decision rests on the assumption that the diffusion time for thin slab casting will be around twice as fast as that of conventional casting. However, notwithstanding this point, there are a number of other reasons that suggest that conventional continuous casting may be the leading production method for large scale producers for some time to come. These reasons fall under two main headings: (i) product range and quality and (ii) process innovations in conventional continuous casting. The LS review fails to give adequate consideration to these two points.

As we have seen the introduction of thin slab casting has occurred in mini-mills where the casters are fed with steel produced in electric-arc furnaces. At present the technology has not been developed to allow conventional steel making to provide the feed for thin slab casters. Moreover, thin slab casting has only been applied to the production of hot rolled strip products and its application to plate production has yet to occur, although it is obviously unsuitable for the production of heavy plate and could, therefore, produce only a limited product range. Hence, by itself, this technology is inappropriate for large scale producers who intend to produce both strip and plate products. These points suggest that, not only may the diffusion time from mini-mills through to large scale integrated production be substantial, but that even after thin slab casting has been adapted to large scale production there is likely to be a role for conventional casting for producers who aim to produce a range of strip and plate products. Of course, it is possible that thin slab casting technology will diffuse through the industry via mini-mill production so that mini-mills capture an increasing market share from large integrated producers. Indeed, a potential danger for large scale producers arising from thin slab casting is that it may undermine the economies of scale that are gained at large integrated sites by competing in selected product markets. To be precise, if thin slab casting can compete effectively with continuous casting at the low-quality end of the market, large producers will have to raise prices at the high-end in order to protect profitability. This suggests that the introduction of thin slab casting may favour those integrated sites producing a relatively high share

of high-quality steels.

As far as the quality of steel is concerned, it should be noted that thin slab casting suffers from a number of drawbacks. Firstly, the larger surface area of thin slab implies that products produced from thin slab have lower surface quality as compared with conventional slab. Second, the greater thickness of conventional slab implies that the surface of the slab remains flatter following any perturbation to the flow of steel. As Reynolds and Distington (1990, p. 45) point out,

"Considering that mould meniscus level stability is the fundamental parameter for good surface quality this represents a significant barrier for near net shape technology to overcome."

Finally, as long as the technology is dependent on scrap-fed electric arc furnaces it will only produce low quality steel. The use of low residual scrap improves the quality of steel produced in electric-arc furnaces but does not result in quality products that can compete with top of the range standards attainable from conventional steel production methods. Moreover, in Europe the comparative scarcity (vis-a-vis the USA) of low residual scrap may significantly reduce the potential cost advantages of thin slab casting in mini-mills. If this is the case then large scale producers in Europe may be afforded some protection from the threat of low cost entry that the mini-mill and thin slab casting poses. Taken together, these factors tend to limit the present applicability of thin slab casting, particularly in the case of Scottish steel production which has a reputation for high quality, high value added products.

It should also be noted that there are several impending innovations in continuous casting techniques which will weaken the ability of thin slab casting to penetrate even the low-quality end of the market. Reynolds and Distington (1990) point to a number of factors that can be expected to significantly improve the efficiency of conventional casting and thus make it more difficult for mini-mills and thin slab casting to compete. To begin with, increased throughput can be achieved by increasing the reliability of conventional casters via the introduction of improved fault detection systems. This would have the effect of reducing 'down time' and increasing the maximum speed of conventional casting above its existing limit of 5 tonnes per minute, compared with the current maximum for thin slab casting of 2 tonnes per minute. Second, greater flexibility and efficiency can be attained from conventional casting via the introduction of three process innovations: width adjustment, combination casting and link casting. Width adjustment permits the production of different widths of steel from a single strand, thus reducing the down time necessary for mould changes. As Reynolds and Distington (1990, p. 45) point out,

"An equivalent process has not yet been derived for thin slab casting because of the difficulty of buckling when deforming a thin edge."

Similarly, combination casting facilitates increases in product range by allowing the simultaneous production of "narrow slabs or blooms down a slab strand" (Reynolds and Distington (1990)).

Link casting allows the production of different grades of steel in a single strand. Again, the main advantage of this innovation is the reduction in down time and the consequent increase in productivity. This point has been neglected by LS who argue that increased product differentiation and demand for specific types of steel will "make it difficult for steel makers to structure throughput in order to generate long production runs." The application of link casting is particularly suited to Ravenscraig where the small size of the converters implies that this site could make significant efficiency gains by tailoring its output to a market that is becoming increasingly specialised and fragmented.

To summarise, LS's arguments regarding technological innovation and thin slab casting appear to be deficient in a number of respects. Firstly, they have failed to provide a detailed assessment of the likely diffusion time for the innovation. Second, they have paid insufficient attention to the limitations on product range and quality and finally, they have emphasised new technology only as it applies to thin slab casting and have ignored important process innovations that are applicable to conventional casting. Not surprisingly, therefore, their conclusion that thin slab casting "could call into question the wisdom of the current wave of modernisation of traditional strip mills." is at odds with the views of leading steel analysts. For example, a recent editorial in Metal Bulletin Monthly

(January 1990 p. 7) argues that whilst thin slab casting represents a major innovation,

"What perhaps has been lacking is a sense of perspective on this development, for remember "conventional" casting, which has done so much for the advance of the steel industry, can not only cast a very wide range of steels, but is not confined to flat products and has a significantly higher production rate. It is in absolutely no danger of being totally eclipsed."

3.1.2 Direct Reduction/Smelting Reduction

Similar points can be made in relation to the process of direct reduction or smelting reduction. Both of these terms refer to process innovations which will by-pass the normal blast furnace-basic oxygen converter route. This, of course, would mean that coke-ovens and blast furnaces would no longer be required. A recent review of Direct Casting has been published in Steel Times. Amit Chatterjee, the R&D Director of The Tata Iron and Steel Co, India argues[5] that direct reduction has '..not lived up to its early promise' in terms of cost and in terms of inherent limitations in coal-based direct reduction which make it unsuitable for producing high-quality products. He argues that smelting reduction has more potential. However, there is, so far, only one smelting reduction plant in commercial operation. The Corex plant commissioned by Iscor (South Africa) has been producing 300,000 tons per annum since 1989.

The most commonly-held view in the industry[6] appears to be that although the smelting reduction process avoids the high investment costs and environmental problems caused by the use of coke-ovens and blast-furnaces, it is by no means an adequate replacement at this time. Indeed, it may well be that the industry will choose to adapt the traditional route to suit changing economic circumstances. Developments such as the injection of coke and coal into the tuyeres, the use of plasma devices to decrease coke rate, and the use of high quality lumps ores to decrease agglomeration costs are proceeding apace. These developments would appear to guarantee a future for the traditional blast-furnace route beyond that suggested by LS.

3.2 Strategic Considerations

The introduction of new technology also poses a problem for BS in a strategic sense. Even if new technologies offer clear long-term advantages, a large monopolistic producer will not rush to introduce these lest its existing investment is rendered obsolete. Rather, it will plan to gradually replace existing capacity with new capacity. These plans are only likely to be upset if new entrants reduce profitability in key markets. Given that mini-mills require less capital investment than todays dominant technology, there is an argument that BS now faces a greater threat of competition due to this potential reduction in minimum efficient scale. We have already argued that these mills will tend to compete at the lower end of the product range. As far as BS is concerned, the loss of profitability on low-grade products could also jeopardise the rest of its product range since large-scale integrated producers cannot concentrate solely on high-grade products. As mentioned above, however, the existing producers can attempt to ward off potential competition by introducing process improvements in the blast-furnace/concast technology.

However, this is not the only form of defence which is available to BS. It can seek to protect its markets by extending its control over steel distribution. Already a very strong force in UK steel stockholding, BS is in a position to squeeze potential competitors by restricting their access to steel users. It may also attempt to stave off competition by entering into long-term contracts with large purchasers of steel. Finally, while the reduction in minimum efficient scale is an advantage to potential new steel producers, it is also a disadvantage in that the capital required to mount a predatory bid is much less than would be the case for a large scale integrated producer. Thus, new entrants relying on mini-mill technology would always be vulnerable to takeover by a profitable large-scale producer who wished to retain control over the market.

Thus, not only are there technological grounds for believing that the advent of new techniques of slab casting and direct reduction will not be as immediate or as dramatic as LS suggest, there are also reasons to believe that BS will try to protect its existing capital base by strategic action in the steel and capital markets.

4. Conclusion

In this paper we have attempted to deal with the

criticisms made by LS with regard to new technological developments. We have demonstrated that the track record of the processes which LS mentioned in their review is not a long or a particularly successful one at this stage. In addition there are clearly problems associated with the introduction of these processes even in the unlikely case that there are no competing developments in existing technology. It is difficult therefore to take seriously the claims of LS especially in view of the fact that they have not presented any costings nor have they considered on-going adaptations of existing technology. In any event, their proposals are certainly too vague a foundation on which to base a survival strategy for the Scottish steel industry.

Footnotes

1. Published in February 1990.

2. Love J and Stevens J (1990) "Steel Production in Scotland: Strategic Considerations for the 1990s - A Review", Quarterly Economic Commentary.

3. For a description of these plants see "Continuous Casting" in Metal Bulletin Monthly, January 1990.

4. T Reynolds and D Distington "What Future 'Conventional' Casting?", Metal Bulletin Monthly, January 1990.

5. "Beyond the blast furnace; DR and smelting reduction technologies", Steel Times International, July 1989.

6. Steel Times International, various issues.

References

Astier J 'Smelting reduction processes carve out an ironmaking niche' Steel Times International, 1990.

Love J and Stevens J '"Steel Production in Scotland: Strategic Considerations for the 1990s" A Review' Quarterly Economic Commentary, 1990.

Metal Bulletin Monthly, 'Continuous Casting', January 1990.

Monopolies and Merger Commission, British Steel Corporation: A Report on the Efficiency and Costs in Discharging its Functions of the BSC. 1988 Command Paper 437, HMSO.

Reynolds T and Distington D 'What Future "Conventional" Casting?', Metal Bulletin Monthly, January, 1990.

Steel Times International, 'Progress made in the IMIS process for direct steelmaking', January 1990.

Steel Times International, 'Beyond the blast furnace: DR and smelting reduction technologies', July 1989.

APPENDIX

There are a number of other points made in the review which are of a political nature and which relate to the campaigning strategy of the 'Scottish steel lobby'. It is not our job as economists to comment on these matters and we were not asked to do so by the commissioners of our report. However, since one of the comments contains a factually incorrect inference and relates to the remit which we were given by Strathclyde Regional Council we will respond briefly to that point. In the concluding remarks of the review the following statement is made:-

"In the December 1989 Commentary it was suggested that the previously solid Scottish Steel lobby has irretrievably fragmented. Thus the Ravenscraig shop stewards did not support or co-operate with the body which commissioned the Glasgow research. It has been suggested to us that, because of this split, those commissioning the study did not wish their consultants to discuss steelmaking or strip making but instead to concentrate narrowly on the plate mill in isolation from the influences shaping the remainder of the Scottish sector." (p. 70)

In response to the first point, we would like to point out that we did, in fact, meet with, and had the co-operation of, the stewards at Ravenscraig both in the production of our March 1988 report which concerned steel production and in the more recent report which did concentrate on plate production. It is our view that the future of Ravenscraig and Dalzell are closely linked and we have demonstrated this point in this paper. With

regard to the second point, the remit we were given was to look at the case for siting a single plate mill in Scotland. It was widely believed by those in the industry and by Strathclyde Regional Council that a decision by BS on this question was imminent and that any research should focus on this question. Hence the LS interpretation (based on 'suggestions' from unnamed sources) is wholly unwarranted.

In any event, we regard the inclusion of these political points as inappropriate to an academic publication. The same can be said of other comments in the review including the criticisms of the campaigning strategy of the steel unions in the mid eighties (p 66).

The review is also riddled with statements such as the following: "..these points in themselves are not sufficient to justify the above assertion and the report has been severely criticised on this basis" (p 65). The inclusion of such statements which seek to cast doubt on our conclusions without any further substantiation other than oblique reference to unnamed critics does nothing to further this extremely important debate and is a breach of academic principles. This paper has been concerned with the substantive economic points raised in the review by Love and Stevens and we would appeal for any further debate to be conducted in a more academic spirit.

A final point concerns the suitability of Hunterston as a site for developing the new technology which LS describe. We acknowledge that the Scottish steel industry would now be able to argue a stronger case for the retention of existing capacity if Hunterston, rather than Ravenscraig, had been developed as the centre of Scottish steel production. However, while this decision is a matter of regret, it does not follow that Hunterston is an ideal site for developing a mini-mill. Hunterston's outstanding natural advantage is its deep-water facility. However, the tonnages involved in mini-mill production are not large enough to effectively make use of this advantage. There are many other sites around the coast of the UK which would be at least as well suited to the establishment of a mini-mill as Hunterston. For example, Invergordon has excellent port facilities, experience of metals production using electrolytic techniques and is better sited for the European market than Hunterston. Further, the port facilities at Invergordon are not controlled by BS. A mini-mill producer at Invergordon would not have the problem of gaining access to port facilities controlled by its greatest potential rival.