LOGGING INDUSTRY RESEARCH ASSOCIATION

NEW ZEALAND

PROJECT REPORT

ON MODELLING THE NEW ZEALAND LOGGING INDUSTRY TO STUDY FACTORS AFFECTING ITS OPERATIONAL EFFICIENCY

P.R.12 1980

N.Z. LOGGING INDUSTRY RESEARCH ASSOCIATION (INC.)

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ON MODELLING THE NEW ZEALAND LOGGING INDUSTRY TO STUDY FACTORS AFFECTING ITS OPERATIONAL EFFICIENCY

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- S U M M A R Y -

Among the many factors upon which the operational efficiency of an enterprise depends, several have been selected for detailed comment, namely, that proper design of management control systems is necessary, that training procedures for first line managers should be developed and implemented, and that the development of new machines has potential to large increases in production capability.

Specifically the following suggestions are made:

(a) that major enterprise should reduce sources of conflict that affect the management efficiency at the general and major function levels;

(b) that the major enterprises modify the economic environments they create for small harvesting enterprises, to give owners of those enterprises incentives to increase both their efficiency and capability;

(c) that the general management of a major enterprise develop system dynamics models of its enterprise to help it view objectively the interactions between its major functions;

(d) that objective models of wood harvesting processes be produced with a view to giving logging managers guidance in judging the degree of wood flow regulation achievable;

(e) that a first line manager (the gang boss) should be trained to plan and organise the working systems of his men and machines, to lead his men with regard to work methods as well as output targets, and to regulate the quantity, quality, and timing of the gang's output;

(f) that the activities of a bush worker should be analysed at a micro-action level with a view to developing better work procedures and to developing and implementing training schemes;

(g) that the Loggers' Association and the Leaders of Industry should take seriously the organisation of annual competitions in each of the manipulative skills used in logging;

(h) there are three possibilities of machinery development which may produce quantum jumps in production capability per man employed, namely, airships for transporting logs, cable haulers for working two faces simultaneously, and cable haulers based on steerable arches.

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- FOREWARD -

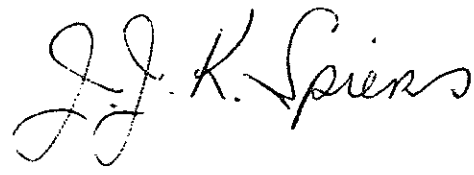
During 1978 Professor H. McCallion of the Department of Mechanical Engineering at University of Canterbury, spent 10 months on study leave, making a "systems" study of the logging sector of the Forest Industry of New Zealand. The overall objective was to point out directions to improve the operational efficiency of logging enterprises and to indicate the role that the Logging Industry Research Association (LIRA) could play in the moves towards increasing operational efficiency in that industry.

McCallion presented a logical foundation for analysing the systems in an industry and then went on to present a report covering many of the factors that affect the functional efficiency of the wood products industry, with emphasis on those affecting the logging sector. He considered five organisational levels ranging from the owners of large enterprises or their agents to the people who actually produce. The operational research needs at each level were discussed.

This paper condenses the presentation of the discussion in the McCallion Report and presents the main conclusions in two categories:

(a) Major premises on which industry organisations with the power to act can undertake changes of direction or changes of operation, and

(b) guidelines for management and action within LIRA.



Director,
LIRA

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- MODELLING THE FOREST PRODUCTS INDUSTRY -

2.1 CLASSES OF ENTERPRISE AND THEIR ECONOMIC PURPOSE

Operational efficiency is a measure of effectiveness used in all classes of industrial enterprise. Efficiency is generally defined as the ratio of the actual output of a system to the maximum output the system is capable of producing without changing its composition, that is:

$$efficiency = \frac{actual\ output\ of\ system\ in\ a\ specified\ duration\ of\ time}{output\ capability\ of\ the\ system\ in\ the\ same\ duration\ of\ time}$$

Therefore, to examine operational efficiency in an industry, operational research is required. By this we mean discovering, quantifying and understanding changes that occur so that people may regulate those changes. To be effective it involves producing objective models of the respective environments so that people may anticipate outcomes of their action.

To study the potential for increasing the operational efficiency of the wood products industry, we need to classify its main types of enterprise, to consider factors causing conflict between their economic purposes and to consider factors affecting their production capabilities and the efficiencies of production.

Two broad classes of enterprise appear to be representative of the wood products industry, they are;

(a) the vertically integrated enterprise which may include forest owning, harvesting, log selling, and wood processing: obviously its economic ideals would be to produce and sell the most valuable products it is capable of making and selling, at the least cost;

(b) the small harvesting or road transport enterprise: its economic ideals should include maximising the value added by its activities and minimising its costs.

Where small harvesting enterprises produce for large integrated enterprises they operate in a powerful economic environment over which they have no control. To encourage them to raise their operational efficiencies changes are necessary.

Consider the following example:

> Given two enterprises, A and B, where B is A's only customer and A's annual production capability is matched with B's expected annual demand but B's actual demand is significantly less than its expected maximum. Let the relative bargaining power of B, relative to A, be such that (a) B may impose a value on A's output or (b) B may change the value of A's output immediately A reduces its annual production costs or increases its annual production capability.
>
> Obviously A has no power to seek its economic ideal or even to regulate its annual income, because it cannot increase the quantity it actually produces beyond B's actual requirements. Thus it has no economic incentive to increase its efficiency of production or its production capability, and no power to increase its operational efficiency.

Essentially, it is economic bargaining power that the small harvesting enterprises lack. For such enterprises to arm itself with the necessary information, any economic bargaining organisation, if formed, would need to employ skilled staff to estimate work content and harvesting costs for each contract under negotiation. This, of course, would increase the overheads of the industry and consequently the harvesting costs. At present, in some cases, the owners of small enterprises may obtain advice from the work study, costing and technically trained supervisory staff of the major enterprises, hence most of them would have little to gain in this direction from a bargaining organisation, if the advice was freely available.

At present there is little real encouragement for innovation or change. I believe that the environment could be changed to encourage the more innovative owners of small enterprises simply by a change in attitude of the managers with the power in the major enterprises. For example, a small enterprise that achieves an increase in production capability through an innovation (a new machine or work procedure) could be given the economic advantage of the innovation for a defined period (say two years), so long as it releases all technical and operational information for use by the industry at large.

It is not suggested that the owners of small enterprises do not achieve satisfaction from their ownership. They achieve a great deal of satisfaction in pursuing their socio-psychological needs through ownership and on a long term basis they are probably able to accumulate much more capital than if they were direct employees of a major enterprise.

2.2 FACTORS AFFECTING THE PRODUCTION CAPABILITY AND EFFICIENCY

For complex systems, capability estimation is very difficult: two main procedures are used, estimation of capability from the best actual output rates achieved and estimation from simulation model studies of the system. The former may involve judgements based upon the historical performance of the system itself, or of other systems such as an inter-firm comparison study. Simulation may be used to draw inferences about the behaviour of the real system by performing experiments on the model: the model may be an iconic model, e.g. a scale model of a cable hauling system, or a symbolic model, e.g. a computer programme for simulating the activities of a logging gang. The simulation model approach is advocated because it leads to the possibility of understanding how the system works.

For a given system capability, a higher efficiency of production may be achieved by increasing the quantity actually produced in a given duration of time: this involves improving the management of the system. In such situations, improving operation efficiency is essentially a management function based on work analysis and design procedures. These procedures may be performed most efficiently by people trained in logical thought processes, in modelling, and in diagnosing operational faults, in planning, designing, and organising systems of people and machines.

Alternatively, output per man may be achieved by increasing the capability of the system. This involves either developing better systems and tools or making creative or inventive leaps in the technology, such as those earlier achieved with chainsaws and rubber-tyred skidders in the industry.

Gradual systematic developments require technical and scientific understanding and are, therefore, mostly produced by professional groups in large enterprises; whereas creative leaps, involving intuition, may be made by anyone with a creative mind, and an acquaintance with the work situation.

2.3 PEOPLE IN WORK

Basically, three things affect a persons work performance - morale, motivation and capability - the latter being influenced by experience and training. Workers are expected to regulate the quality, quantity and timing of the output in the face of significant environmental variety in logging. They may learn, they may invent and develop tools, they may also plan for contingencies.

A motor-manual worker, the bushman, must train and the training must be reinforced by good supervision. Appropriate protective clothing for New Zealand conditions should be investigated. Tree and stand parameters vary and affect the quantity and timing of the bushman's output. We need to know the influence of the relative factors on his productive capability, for example, what is the influence of ground slope, slash, undergrowth, etc, on his speed?

As far as I am aware, there is no explicit, formal, objective, quantified model with which to judge the influence of chainsaw weight, power, chain speed and guide-bar length on the efficiency. If such a model does not exist the omission should be rectified, because motor manual chainsaw operations are likely to be with us for the foreseeable future, particularly on steep slopes.

In contrast, a machine operator is not subjected to weather or ground conditions but he may be subject to physiological discomfort or strain due to mismatches between his body and the position and actions required of it by the machine. He may also be subject to socio-psychological discomfort due to isolation from other people and due to the repetitive nature of the activity.

Micro-action studies of the basic mental and physical activities of an operator with his machine should be undertaken aimed at more efficient training procedures. For example, the most skilled activities are likely to be (1) judging whether or not a tree is within the capacity of the machine, (2) positioning the machine, (3) judging the acceleration and impulses, (4) driving at speed through standing trees or stumps, (5) judging the degree of stability and its load for combinations of ground slope and vehicle linear and angular velocity, (6) positioning the tree or trees on the ground. It is suggested that instrumented machines be set up for training purposes.

A maintenance fitter welder, although not a member of the bush gang, should be studied as an active repairer of a machine because his activities have a significant influence on the efficiency of production of a gang. He is often subjected to mismatches between the structural properties of a human body and those of the machine. He may even injure himself as he attempts to produce a desired outcome. Except for scheduled lubrication and maintenance activities his actions are initiated by events in his contingent environment. He must diagnose and he should be trained in this activity and diagnostic aids should be available for each machine he is required to work on. Many of his actions have a probability for undesirable outcome, e.g. it is common for them to allow the ingress of foreign material when working on hydraulic circuits. Good training and supervision is essential.

2.3.1 RESEARCH NEEDS ASSOCIATED WITH BUSH WORKERS

I believe his activities should be modelled on a more scientific basis than that used currently. The more scientific models could then be used to study the influence of terrain, crop, machinery and personality factors on the production capability of workers and their machines. The results of these studies could be used to develop improved work and training procedures. It is suggested that the more scientific models should be based upon basic actions of people such as movements of, and applying pressure with, various parts of the body; making observations; choosing

a course of action; and regulating the position of an object or a machine.

Using the basic elements I believe that objective studies could be made on the influence of terrain, crop, machinery and personality factors on the man-machine system capability. Although it will require considerable thought, the models should be designed on a common data structure and on a common organisational form, so that they may form the building blocks of a simulation system. Ideally they should be available interactively on a digital computer so that researchers and methods designers could use their intuition in "working the system".

With regard to training and reinforcing skills, improved or new courses of action can be developed if the performers are properly trained. Most people operating at this level have not developed the ability to learn from written or even generalised oral communication, thus knowledge of the course of action should be communicated by demonstration. After all, people are taught sport this way because the mechanics and physics of the processes are usually too complex for comprehension. The more advanced courses of action need continual reinforcement. This can be done to a limited extent by supervisory action but I believe it is more desirable to make use of socio-psychological motivating factors. Most people enjoy being looked on as very skilful and will attempt to imitate the actions of very skilled members of their work or social group. Encouragement of skill could be achieved by initiating competitions in logging skills at the Forest, Provincial and National Levels. Such competitions have the added advantage of encouraging people to imitate and think more about the courses of action in their daily work and thus achieve efficient and safer procedures. The Leaders of the Industry, through say the N.Z.L.A., should be involved in framing the rules of each competition and in helping organise them. Such a venture could help public relations for the industry, particularly bringing it to the attention of younger people.

2.4 FIRST LINE MANAGERS

The first line manager (the gang boss) needs to be able to plan. Generally he will be given production targets in a specified harvesting area; the number of men and classes of machine will be specified by his logging manager. His tasks are to organise work, and to communicate to the men what they must do. Within the production target constraints he will be expected by his men to regulate the variations in their earnings and to balance the work content so that they do not suffer low incomes for prolonged periods.

When he has inexperienced men in his gang he will need to know how to train them. To keep a highly producing gang together, he will need to be able to motivate them in ways other than financial, e.g. some people like working for a competent organiser or for a stimulator of new ideas. When there is not a company or industry training scheme he will

need to be aware of a range of ways to perform the tasks of each of his men and to be able to encourage them to become skilled and to use the most efficient procedures. He must also be capable of monitoring the quantity, quality and timing of the output of his men and of communicating to them how to meet his targets. His inter-system tasks include communicating with other people on quantity, quality and timing targets for his gang and on the maintenance needs of his gang (for repairs to machinery, replacement of people, supply of fuel, etc.).

Hence, in addition to planning how to achieve given production targets, his training should include (a) how to design working systems of men and machines in a range of types of harvesting situations (this I believe could be done with iconic models such as is used in war games) and planning what to do in cases of machinery breakdown, absence of men, accidents, weather changes, etc.; (b) how to organise the systems, that is, how to integrate and co-ordinate the actions of people; (c) how to encourage his men in the selection and continued use of good work habits and attitudes and in desiring to meet their given quantity, quality and timing output targets, and (d) how to regulate the quantity, quality and timing of his gang's output where self-regulation is not satisfactory, that is monitoring the output, inferring the causes of the deviations and possible cures, and communicating the possible cures to his men, which is largely a training function with inexperienced gangs.

In the present social climate his training should encourage him to share all operational information and to discuss system arrangements and work methods with his gang.

All this is asking a lot of most people; aptitude tests could probably be useful in screening out obviously unsuitable candidates.

I believe that the large range in production rates actually achieved, by gangs with nominally the same capability, is due to poor first line management.

2.4.1 RESEARCH NEEDS ASSOCIATED WITH THE WORK OF FIRST LINE MANAGERS

If the basic, objective, quantitative, models of individual person-machine systems, were designed on a common data structure and organisational form, it would be possible to bring them together so as to model the set of integrated and co-ordinated activities of a harvesting gang.

These models would also enable work planners to study the influences of terrain, crop and machinery factors on system capability. And the capability studies could form a basis upon which to investigate factors affecting the efficiency of production of a gang, that is, work study measurements could be compared with simulation results and major differences investigated.

These models could also form a basis for the design of realistic harvesting games for use in training first line managers.

In the absence of the basic models of individual person-machine systems, approximate representations such as those described by McCraw and Silversides (Ref.1) could be used as a basis for designing systems, and for planning their use: and that described by Martin (Ref.2) could be used as a basis for designing a training model for first line managers.

2.5 MANAGERS OF MAJOR FUNCTIONS

Logging management has the task of planning, at the strategic level, the system to be used, taking cognizance of the terrain and tree parameters. These managers are concerned with regulating the costs, quantities, quality and timing of the wood flow. From site investigations, giving tree quantity and quality and terrain quality, work content and harvesting and transporting costs should be assessed for a range of systems believed capable of meeting the wood flow targets.

I believe that operational research is needed to produce objective models of the processes, for planning at this level.

Managers of major functions need to know what to do in the case of strikes and mill breakdowns, prolonged good or bad weather conditions and so on.

Logging managers appear to negotiate contracts with small logging and transporting enterprises, but the small logging enterprises lack the technical expertise to assess objectively the work content in a cutting area and, hence, to assess the costs for specified wood flow rates. Therefore, I believe that logging managers do not so much negotiate contracts as let work on a cost-plus basis. The major enterprises have all the power: the small enterprises can accept or close down. They are in what the social scientist graphically call a vortical environment, that is, they are in a whirlpool being kept up only by a rope from a major enterprise. Logging managers appear to be responsible for keeping them alive.

The logging managers of major enterprises are responsible for organising their direct labour force. Hence they should be able to infer, in detail, the work procedures a gang could adopt, test out a range of procedures, and select the most satisfactory on economic criteria. There is a considerable amount of work study data available but I believe that it is not in an appropriate form for objective analysis of the options available. The work study elements should be synthesised from the basic micro-action data mentioned in relation to the man-machine level actions. The influence of terrain, tree and forest stand parameters on harvesting costs could then be cheaply assessed by simulation techniques, and validated by a small well designed set of field trials. At present, as I understand it, ad hoc field trials are undertaken

to test out hunches. Truck scheduling should also be studied at this level, although the beautifully simple scheduling system developed by N.Z.F.P. is probably all that is needed to regulate the operations of all but the most complex harvesting and wood selling enterprises.

The logging managers should lead their first line supervisors to adopt well regarded attitudes and to choose the best systems for organising their gangs. The managers should also motivate them to meet quantity, quality and timing targets. On the assumption that the bush workers are paid for time with bonus on quantity and quality I believe that much more use could be made of man's natural competitive spirit, in motivating first line managers and consequently their gangs: the output rate of each gang should be open information to all gangs.

The payment scheme for directly-employed road-transport drivers may be producing difficulties in regulating their short term (hourly) rate of delivery of wood to a mill. For example, if a man is paid a higher rate for overtime and if it is not possible by good supervision to regulate his trip time, then it is common knowledge that many will "spin out" trips to earn overtime each week. If it really is a problem to the industry, negotiation with the Union would be necessary to change the basis to say a weekly rate plus bonus for wood delivered on time.

Regulating the subsystem outputs at this level is more a case of organising those aspects of the system which form environments of the subsystem so as to encourage self-regulation. An example would be the suggested revised payments scheme mentioned above. Regulatory action would then be necessary only to balance the quantity, quality, timing and costs of wood flows to meet the demand for wood, within the regulatory capability of logging managers. I believe that quantitative objective models are required to help managers judge the influence of their regulatory actions on the capabilities of their systems.

2.5.1 RESEARCH NEEDS ASSOCIATED WITH THE WORK OF LOGGING MANAGERS

Probably the main responsibility of logging function managers is the regulation of wood flow from forest to mill. Therefore, in connection with week-to-week regulation they should be interested in wood flow simulation models that estimate flow rates in specified situations and that indicate the sensitivity of those rates to contingency environmental variables such as terrain, crop and weather conditions. They should also be interested in the breadth of the probability distribution of flow rates because broad distributions indicate situations that are difficult to regulate. Hence they highlight areas requiring research to discover what produces the "scatter".

2.6 GENERAL MANAGEMENT

I shall assume that the operational efficiency of the whole enterprise depends principally upon the operational efficiency

of the wood processing systems in the sawmills, pulp and paper mills and chip board plant, because these systems involve high capital investment. Hence, they must be kept working to the maximum capacity that can be absorbed by the market. Therefore, the logging sector which is much less highly capitalised must be able to supply sufficient wood for the demands of the processing sector. Unfortunately the regulation of wood flow is not easy, due to variations in environmental states, which influence the rate at which wood is harvested, transported to the mill and processed; and due to variations in end-product market-demand. The fact that bush workers work a five day week and the mill operates seven days per week also produces a regular major fluctuation in wood flow rate. However, the statistical characteristics of each of these sources of demand variation could be determined and using prediction techniques tactical plans could be produced as a basis for regulation of wood harvesting.

The usual instrument for smoothing short term fluctuations in a flow process is the stockpile but with the major species of wood involved, wood stockpiled in open conditions degrades due to sapstain. The response time is temperature and humidity dependent, and regulation of these properties for large stockpiles is expensive.

The next most effective course of action would be to plan for flexibility in harvesting rate, which means flexibility in number of men employed. With bush workers employed directly by the major enterprise this could be accomplised by training the workers to be multifunctional (e.g. to function in forest establishment and silvicultural situations as well as in harvesting) and then planning, on say a rolling 36 month basis, the total work content and labour requirements for forest establishment, silvicultural treatment and logging. I believe that there is considerable flexibility in the timing of ground preparation, planting, pruning and thinning; this could be used to absorb the fluctuations in labour requirements for logging.

There is another possible course of action for smoothing fluctuations in manpower requirements that result from fluctuation in mill demand. It is to develop a market, for logs, with the necessary flexibility, that is a market that would take the fluctuating quantity of logs produced in excess of mill demands. To a limited extent the current Log Export market does this.

There are of course other ways for increasing the flexibility in harvesting rates but they are probably less acceptable within our present culture.

In planning, general management would be helped to view objectively the interactions between the major functions (forest management, logging, mill management, plant maintenance, personnel, and marketing) if it had an overall system dynamics model of their enterprise (e.g. see Refs. 2, 3,). The procedures for development of such a model are well known but the design and organisation of the components and the

evaluation of its parameters are specific to an enterprise. In addition to giving an objective basis upon which to plan, the model may encourage research into such inter-function questions as: "Is it more economical to trim to a high quality in the bush or to introduce more suitable machinery in the wood room?" or "Would it be more economical to train logging machinery operators to do machinery maintenance to a higher skill level?" or "Does a central maintenance facility lead to a higher overall operational efficiency than distributed maintenance facilities?" and so on.

Where the forest is large and its structure complex, the markets many and dispersed around the forest, and the product mix of each market is complex, choosing the cutting areas for lowest delivered cost of the logs could be a difficult task. As it involves forest management, harvesting and transporting the logs to market, it involves decisions by general management. Assuming that these activities are planned on a rolling five year basis and that the total harvesting cost is insensitive to the order in which the stands are harvested, then the principal variable in the cost of delivering logs to the market will be transportation costs. The choice of which stand to harvest for a market could be guided by a linear programming algorithm for minimising the transport costs. For Kaingaroa forest, Hill and Goulding (Ref.5) indicated that savings in transport costs in the region of one million dollars per year (i.e. 5% of present costs) are available under such guidance.

When a conflict of purposes arises and the type and size of trees allocated by the forest owner is not suitable for the mill processes, the harvesting and wood processing enterprise has additional difficulties in achieving a high overall operational efficiency. Only a quantitative technical/economic appraisal of the joint forest owning/harvesting and processing operations could guide the choices available jointly to the owners of the enterprises or their agents, preferably for the benefit of the society they both serve.

In summary, at the general management levels, choices could be made to ease the manpower and wood flow regulation problems of logging managers. I believe that a consequential benefit would be a work force with a higher morale and an atmosphere which encourages improved methods and innovation.

2.7 OWNER OF A SMALL HARVESTING ENTERPRISE

Although the owner of a small harvesting enterprise spends most of his time in first line management he must also act as its general manager and director. In his general management role he plans and organises the resource supply function and the maintenance function of the enterprise, the actions being performed by other enterprises. He also probably engages a professional accountant to help him in his management role.

It appears to me that his most critical managerial task is regulation of the enterprise's cash flow: it involves understanding concepts relating to non-steady state phenomena, which untrained people usually find very difficult. Because various factors interact in time and there are different response rates, it is virtually impossible to find analogies with which to build images, hence untrained people have difficulty.

In addition to the possibility that they find the concepts difficult, I believe that these owners have little power to regulate the cash flow of their enterprises.

Cash flow depends upon inflow and outflow. The cash inflow of a small enterprise is controlled by the major enterprise for which it works. For any "contract", work study and costing staff of the major enterprise assesses the annual output capability of a contractor, and the costs it would incur by using what they believe to be the appropriate work procedures. With this information they set it an annual production target and a price per tonne of logs produced. In effect the "contracts" are on a cost-plus basis but different calculation procedure are used by different major enterprises; some scale the expected output down to a "just" rate, others add a percentage to the estimated cost as a "just" profit.

In the present inflationary state of the National economy, there are additional complications in deciding a "just" rate of return on the owner's equity.

Usually, the owner of the small enterprise is unable to pay for the major items of plant from his own funds, especially in the early years of the enterprise. Hence its cash outflow will include payments to the finance houses in addition to those for wages and bonuses, fuel, plant maintenance and taxes. Obviously the owner has little power to regulate any of these payments.

It may appear that he can regulate cash inflow by producing at higher than the "just" rate, for example, by increasing its operational efficiency or by working longer hours. This is an illusion; the major enterprises are attempting to regulate their week-by-week wood flow rates, and over-target production by small enterprises is not in their interests. Hence it is natural for the major enterprises to limit the output or even eventually to cut the "contract" rate if a small enterprise, by innovation or otherwise, increases the weekly production rate it is capable of achieving; if this were not so the major enterprise would have difficulty in regulating its wood flow. An innovative improvement in operational efficiency would thus benefit the major enterprise by lowering wood costs but if it involved the small enterprise in the purchase of expensive equipment or in high development costs, it is possible for it to be in an even less secure cash flow situation. As I see it the small contractor also has little incentive to improve productivity by training or by better management. The major freedom to regulate cash flow is for the owner to do his own plant maintenance, book keeping, etc. in his free time at no charge to the enterprise.

To allow for uncertainty in weather conditions etc, it is necessary for most small enterprises to be able to produce at a higher rate than that used by the major enterprises in setting their annual targets; but for cash flow and profit reasons their owners wish to produce over target, with consequent conflict between them and the management of the logging function of the major enterprises. The small contract logging gangs should be educated to have some understanding of the problems of wood flow regulation.

I believe that even under the present "contract" system, major enterprises could help find a cheaper and less overpowering means for financing the equipment of the small enterprise and so reduce harvesting costs. For example, the major enterprises could probably borrow money and loan it to them at 50 to 75 per cent of the rate small enterprises must pay. The major enterprises could also help smooth the cash flow fluctuations of the small enterprises due to say sharp decreases in demand for wood arising from mill breakdown, strikes, etc.

The owner of the small enterprise may also need to regulate the capability of his system; for example, when an experienced man leaves him and is replaced by a novice, the system capability could decrease. However, compared with the influence that the quality of his own managerial ability has on system capability, I believe that perturbations due to training a novice are small.

2.7.1 RESEARCH NEEDS OF OWNERS OF SMALL HARVESTING ENTERPRISES

I suggest that owners of small harvesting enterprises are not able to recognise that they have research needs; because they lack the necessary formal knowledge, understanding, and experience of technical situations. What is more they would be unable to interpret generalised research findings or to use generalised management aids produced by research workers.

However, a few progressive owners, who achieve satisfaction by developing new machines or new work procedures, are likely to benefit from help based upon interpretations of existing knowledge. Consultant engineers, foresters, accountants, etc, offer such services. For example, if an owner has regular troubles due to metal fatigue, excessive wear or excessive vibration, in a machine he is developing, he could be helped by an engineer issuing instructions on what changes to make. Similarly if the owner is developing a new work procedure he could be saved time and money by having help based upon work study and the planning expertise of a forester. I am suggesting that the owner of a small enterprise needs the help a consultant would give to a layman rather than the conceptual advice given by research workers to professionally trained people.

2.8 DEVELOPMENT OF NEW MACHINES

Given the tree characteristics and the terrain, quantum leaps in production rate per man are possible only by introducing new machines. For the harvesting process on flat or gently sloping land many machines are already available and others are under development overseas. Probably all we need to do in New Zealand is to remain aware of the possibilities until they become economically or politically attractive. However, there are two activities for which the development of new machines may be worth exploring within New Zealand, they are long distance transport of logs from bush to port or mill, and short distance hauling of logs in steep country from stump to landing.

Aero-space Industries of Hamilton is engaged on design studies of load-transporting airships. In view of the existing costs and expected future problems of transporting logs from remote forests to ports and/or mills, I believe that Aero-space Industries should be approached to make technical and economic studies of airships for transporting logs. This possibility conjures up many other ideas, such as using the airships to build up floating off-shore stock-piles to reduce port handling charges.

With the geometrical properties of New Zealand's steep afforested country, it appears to me that many ideas could be generated for reducing the stresses in hauler ropes or for increasing the haul rates of haulers. For example, one hauler could be designed to operate in two hauling strips simultaneously, thereby doubling the haul rate for an increase of say two breakers out: for a significant range of terrain it would probably be feasible to use a steerable arch, similar in principle to scrub crushing rollers, for hauling trees, thus eliminating the need for a highly stressed skyline.

Exploring possible innovations such as the above is likely to be expensive and I believe that in the vortical economic environment in which small contractors exist they have no incentive to do such exploration. Therefore, it would appear that not only is the careful technical/professional type development in the province of the major enterprises but so too must be the risk-taking New Zealand based machine-developments.

- 3 -

- ON THE ROLE OF LIRA -

3.1 WHAT IS LIRA'S ROLE ?

Because the relative economics of various silvicultural regimes depend upon the operational efficiency of the associated thinning processes and of the subsequent harvesting processes an overlap between the activities of LIRA and FRI would appear inevitable. However, assuming that at present ignorance prevents us from modelling the total system, from planting to delivery of wood to the mill-door or to the wharf, in sufficient detail for optimisation studies to be made, sensitivity studies may proceed by detailed models of one phase embedded in broad representations of other phases.

Thus research into the Economics of Silviculture is concerned with modelling the silvicultural processes and their influence on the cost of producing wood with existing harvesting systems; hence those workers need to measure the parameters of and to model existing harvesting systems, but their primary interest is to understand the influence of changes in silvicultural parameters on the economic capability of the overall system.

Research into the operational efficiences of the logging and transport processes should take, as given, the silvicultural regimes adopted in practice and attempt to understand the influences of changes in the actions of people, and the machines on the production capability of systems. This is the area of activity for which LIRA was set up. LIRA could also cover investigations into reasons for differences between the operational actuality and the operational capability of the systems, that is, problem situations due to poor management found to be common to many enterprises in the industry.

Having delineated LIRA's area of activity, let us examine the potential form of that activity. I see five potential forms of activity:

1. Information collecting, digesting, and disseminating;

2. Consulting: on good Practice,
   : on day-to-day problems with machinery or with work procedures,

3. Major research investigations
   : generalised quantitative modelling of operational situations,
   : development of new harvesting machines or socio-technical systems,
   : development of new planning procedures.

4. Training : designing and developing new work procedures,
   : designing and developing new training programmes for the new work procedures,
   : training those who would train the workers.

5. Public Relations : e.g. exhibitions, national competitions, etc.

Let us consider them in turn.

Information processing -

There is so much information, relevant to the aim of increasing operational efficiency, available from overseas and from the major enterprises within New Zealand, that obviously LIRA's first priority must be and is to collect, digest and disseminate that information. A very comprehensive library of logging matters is being assembled. Newsletters, Machinery Evaluations, Reports and Digests are being issued. Seminars have been and continue to be organised.

However, there is a difficulty; the difficulty in knowing to whom the information is to be communicated. I would suggest that that aimed at manual workers should be communicated enactively, that is, by films, by one - many practical demonstrations in the forest, or by one - few instruction in operational situations in the forest: to first line managers it could be communicated enactively or by one - one discussions or by one - few oral instruction: to technicians, that is people trained in routine technical procedures, it should at highest be in the form of written communications about actual situations, that is, the symbols used should bear a one-to-one correspondence with reality: and, of course, on topics within the competence of a professionally educated and trained person the highest level of communication involving generalised concepts or one - many correspondence between symbols and reality may be used.

It is difficult to decide where the majority of LIRA's audience is. For its written communications, the audience is probably the management of the logging functions of major enterprises. In my judgement, the owners of small enterprises require a consulting service to solve day-to-day problems rather than one issuing written technical information. They want instructions on how to overcome existing problems rather than technical information that involves interpretation and judgement in choosing courses of action to remedy the troubles. However, in the management control area I feel that the owners of small enterprises would be interested in written information so long as the reading age for which it was written was appropriate: a reading age of 12 to 14 years at most should be aimed for. The writing of such publications may require specially trained staff. Courses on management topics (e.g. managing people, managing finance), that is, direct instruction not seminars or conferences, should also be considered for these owners. I believe that such courses should be taken to the audience rather than presented in the LIRA offices.

Consulting

In my judgement the staff of LIRA already act informally as consultants on good practice and on helping to trouble-shoot problems with new machines and new work procedures. When they make their frequent field visits to gangs, much of the conversation relates to good practice and current troubles. I believe that a formal consulting service could be made available in this area without detriment to consulting enterprises and to the advantage of the industry.

The other forms of consulting, i.e. work study, cost evaluation, planning of the operations of complete contracts and generally acting as an agent of an owner, is justly considered by the Director of LIRA to be in the province of consulting forestry and accounting enterprises.

Major Research Investigations

As recommended in the Groome report (Ref. 6) it was not intended that LIRA should be staffed, financed or equipped to undertake what I would regard as a major research investigation. However, in my judgement the industry needs research that establishes generalised quantitative models of operational situations including the influences of physiological, psychological and social parameters. This should be an activity of LIRA. From simulation studies with those models I would expect LIRA to be able to suggest potentially profitable new developments in machines, socio-technical systems and planning procedures. I would expect the major enterprises, guided by LIRA, to carry out the developments.

Training

It is in this area that LIRA could make most impact on the work capability and efficiency of the manual workers of the industry. As I envisage it, on the basis of simulation studies, new work procedures could be investigated and developed, and then new training procedures designed and developed. Ideally LIRA would need a couple of technicians (Methods Development Loggers), that could perform all the bush workers' manipulative skills, to perfect the procedures and then to train those who would train the bush workers. From its researches and design studies into the organisation of socio-technical systems LIRA could also develop training schemes for first line supervisors based upon a management games approach.

Public Relations

LIRA has been and is involved in National Conferences and Exhibitions. Except possibly to act as consultants on work procedures to competitors, I would not envisage it being involved with the annual competition in bush workers' manipulative skills that I have suggested should be organised.

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