LOGGING INDUSTRY RESEARCH ASSOCIATION
NEW ZEALAND

PROJECT REPORT

CABLE LOGGING SEMINAR

VOLUME II

PAPERS TABLED

P.R.6 1978

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

P.O. Box 147 Rotorua New Zealand

Project Report No.6
1978

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VOL. II

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ACCESS TO/USE OF TECHNOLOGY

DR.M.C.PROBINE
DR.G.F.STUART

NOTE: *This paper was prepared for another purpose and does not apply specifically to logging. It is a background paper to some of the points Dr. Probine wishes to make.*

INTRODUCTION.

Every firm must keep an eye on changes in its environment. These changes present both threats and opportunities. Technology is part of that environment and,if observed and managed with imagination,the firm may look to the future with feelings of security.

Technology has made significant contributions to the vitality of the small business community, as well as the economy as a whole. In the paper we will be considering relatively small firms producing products requiring a high degree of skill, and innovative flair, and products which can compete on world markets on quality, price and design. We will discuss the problems that such firms have in obtaining access to, or in using, technology; and draw attention to resources which are available for them to draw upon.

RESEARCH AND DEVELOPMENT.

By the very nature of most small businesses these firms generally do not have formal research and development (R & D) organisations. Nevertheless, these companies benefit substantially from the research and development carried on elsewhere, both here and overseas, by large and small companies, as well as other R & D performing organisations.

But let us first be clear on what we mean when we talk of Research and Development. Research and Development can, and has, been defined in a number of ways. For the purposes of this paper we have taken a wide view of what may be included within the term R & D: it includes the whole spectrum of activity from basic research, through applied research and experimental development, up to the stage of testing of prototypes and operational pilot plants. While it applies to a wide range of activities, all of these activities do not have to be followed through in a sequential process for R & D to be carried out. Also, R & D can apply equally to the simple inexpensive item, or improved operating process, as it can to the large spectacular, high cost, breakthrough.

Innovation is the using of an idea - the whole process by which the idea gets translated into a product and brought into the market place for the first time. We should remember that innovations do not have to come out of a formal R & D programme but refer to technology being used or applied for the first time.

Since the primary goal of all companies is to show a profit each year, it is obviously important that R & D effort of each firm be directed towards contributing to that goal. In companies where the product life-cycle is short and products are threatened with early obsolescence, Research and Development is important as a means of obtaining new and improved products. In order just to survive, companies in many industries must market new products and utilize new processes as fast as the state of the art permits.

Advances resulting from a company's successful R & D effort will give that firm a competitive edge in the market place during the short term, assuming that the advances can be successfully assimilated into the company's product line. In order to gain this competitive edge, the company must develop and market this new product rapidly. In order to maintain the competitive edge, the firm must continue its work at advancing the state of the art, thereby continuing to improve its product. This is particularly true for those products which have a high technological content. By introducing a better product ahead of its competition a company gains a significant edge. By continuing to make better products than its competition a company becomes a leader in its field. Becoming a leader can lead to new business for the company, which in turn can mean more profits and more growth.

Research and Development can also provide greater efficiency in day-to-day operations. This improved efficiency can result in the manufacture of current products at lower costs. This is another way for a company to gain a competitive edge.

BASIC REQUIREMENTS FOR SUCCESS OF TECHNOLOGICALLY INNOVATIVE COMPANIES.

Fundamental to the success of any company is top quality management of the functions of manufacturing, marketing, finance and personnel. In any operation, the emphasis given to each function depends on many factors, including the size of the firm, the type of industry, technological requirements, and style of management. For the technologically innovative firm a number of important characteristics for success have been identified in overseas studies. The most discriminating factors distinguishing successful and unsuccessful innovations are:

1. Successful innovators have a much fuller and more imaginative understanding of user needs: successful innovations need less adaption by users and need fewer modifications as a result of user experience. Successful innovators see user problems earlier and understand user needs better, than do failures.
2. Successful innovators pay more attention to marketing and publicity; successful firms employ greater sales efforts, devote more effort to educating users and give more publicity to the innovation, than do failures.
3. Successful innovators make more use of outside technology and scientific advice: successful firms have better coupling with the scientific and technological community in the specialised areas concerned, benefit more from dependence on outside technology during production and have better internal and external communications, than do failures.
4. The responsible individuals in the successful companies are usually more senior, and have greater authority, than their counterparts in companies that fail: in successes the innovator within the firm is a person with authority and responsibility, diverse experience (including overseas experience), higher status and more enthusiasm for the innovation.
5. Successful innovators perform their development work more efficiently

than failures but not necessarily more quickly. Successful innovations have fewer bugs and need fewer unexpected adjustments in production, have fewer after-sales problems and are less modified during the course of production than failures, and they do not require modifications after commercial sales. Successful innovators benefit from outside technology during production, make more use of development engineers in planning and costing for production, do not order new tools or equipment for commercial production before the decision to launch a full-scale production has been made and do not underestimate production costs.

It is important to note that the factors relating to the innovator's degree of understanding of user needs and his marketing, sales and after-sales effort have, generally, the greatest significance in differentiating success from failure, but the technological back-up must be there to research and develop the innovation and support it throughout its life cycle from idea to after-sales service.

It is worthwhile considering briefly some of the specific factors relating to the successful innovations.

- About 75% of successful innovations come from "need-pull" as distinct from the"technology-push" of major break-throughs; this is important from the point of view of technological support services.
- Many innovations of great commercial significance are of the relatively low-cost, incremental type, the result largely of continuous development efforts.
- Most of the ideas successfully developed and implemented by any firm come from outside that firm; this is important when considering communications of technology and also licensing "know-how" agreements.
- The cost of originating and developing a successful innovation is a minor part (probably 15 to 30 percent) of the total cost of bringing it into use.
- Larger firms do not seem to develop a greater proportion of innovations, relative to their market share, than do smaller firms.
- There is a substantial lag, 8 to 15 years, between the time new technical information is generated and the time it is used in an innovation. The lag appears to vary with industry, product, market and resources used, and with the stage a firm enters the cycle.
- Education is the primary avenue through which basic scientific findings are translated into engineering practice; the individuals involved in generating successful innovations are a well-educated group.
- Most of the information used in problem-solving comes from within the firm, but this is usually brought into the firm by one or two key personnel who have had extensive contact with other firms and organisations and with the technical literature; to firms the important point here is the establishment of policies designed to encourage the development of informal channels or communication or, at least, designed not to impede this process.

Although only limited studies have been carried out here, few would disagree that the above factors apply, at least to some extent, to small-scale New Zealand manufacturing. Preliminary results from studies currently under way of technology in New Zealand firms can "fingerprint" the good and the poor firm (in a technical sense).

"Good" - experienced and high calibre technical staff; a good understanding, perception, and identification of their problems: active use of the technical literature relating to their field; a good understanding of "user" needs; a realisation of the importance of quality control; a good knowledge of the technical resources available to help them; effective use of overseas "know-how" and agreements.

"Poor" - inexperienced or indifferent calibre technical staff; a poor perception of their problems; poor knowledge and use of the technical literature; too much reliance on materials and equipment suppliers for technical help and advice; little appreciation of the importance of quality control, over reliance on DSIR to solve all their problems on a "fire engine" basis and little capability to ensure that the same problem does not arise again.

There is little that outside 'resource' organisations can do to assist the "poor" firms in any real way - and, in our view, such firms have little place in New Zealand's development. The firms that can best be helped by DSIR, and other similar groups, are those that help themselves.

COMPANY SIZE AND INNOVATIVENESS.

No correlation has been found between scientific and technological productivity, or innovative capability, and corporate size. There are obvious advantages in being large; but from an innovativeness point of view smallness is not always a disadvantage.

In a small firm, with an enthusiasm for product development, staff can see a clear relationship between their own efforts and the success of the company and with close personal communications are therefore usually highly motivated and produce their best work. Again, a small company is often able to develop a close working relationship between itself and its prospective customers in a way which is not possible, or is more difficult, for the large and more bureaucratic companies.

Further, small companies are often able to respond more quickly to new development opportunities than are large companies. This ability to respond quickly is an advantage; but, since this ability to respond quickly often involves the taking of risks, it also requires a highly developed judgement by management as to which risks are acceptable and which risks are not.

To take an overview, evidence suggests that the small to medium-sized firm has a comparative advantage in pursuing a technology-dominated strategy.

- It is more likely to be the source of key innovative ideas.
- It has more entrepreneurial and risk-oriented leaders eager to push innovation.

The contrast is between the game of "you bet your company" with an idea for the smaller company, and the inertia, inflexibility and pride (that if it is "not invented here" it cannot be good) of the larger company.

Of course there are disadvantages (some of them are major) in being small.

One of the major disadvantages relates to the availability of capital and the uncertainty of success in research and development. Even though R & D is important to both the survival and growth of the small company, particularly those in high technology idustries, there are important other areas competing for available funds. Furthermore, because of the expense associated with maintaining diversified R & D efforts, most small companies confine activities to areas directly related to their current business and find it difficult to broaden out into new potential growth areas.

Small companies cannot afford to finance very many unsuccessful projects. They do not have the financial capacity to sustain long-term losses. Therefore, most small manufacturing companies must, of necessity, forego long-range R & D work that does not have a high probability of success and concentrate their efforts on short-term work with virtually certain success. At times, in the hope of saving money, but in reality increasing losses, a company may take short cuts on R & D and not achieve a commercial success through not satisfying customer needs.

Some other problems associated with research and development in the small company are the limited availability of high quality creative manpower and the inability of the company to attract, and retain, such people. The smaller facilities impose restrictions on the maximum size of an R & D programme and limits the scope for team research and interaction of staff with outside organisations.

The above problems are particularly relevant to active companies. The inventor-entrepreneur who is interested in starting a small firm is faced with a myriad of other problems. Typically, these people are science-oriented with little or no business experience. They need venture capital and many times are unfamiliar with the venture capital market. The new company, once it gets started, generally has only a few customers and must try harder to please each one. To lose even one customer could mean disaster.

Problems which small companies face are real and need to be faced; but it does not mean that such companies cannot be successful. Indeed some of the more important innovations of this century have come from small companies and organisations. But problems of the kind listed above exist, and we should recognise them and work to minimise the effect of such problems.

ACCESS TO RESEARCH AND DEVELOPMENT ASSISTANCE AND TO TECHNOLOGICAL SERVICES.

One of the ingredients to success which we mention above was that small companies need to develop good coupling to the scientific and technological community outside of the company in fields related to the company's activities. In the following sections, we will summarise some of the facilities which are available, and point to some of the gaps in our present services which yet require to be filled.

DSIR.

For growth in industrial development it is important that countries like New Zealand make the best use of available technical resources. Apart from in-house research and development, the principal research and technical advisory services available in manufacturing and processing industries are those provided by DSIR, by the various research associations, and the universities.

Companies which are involved in the development of new products or processes, or in the introduction of new technologies from overseas, should be aware of the services which DSIR offers. Below we have endeavoured to summarise in general terms the department's principal activities; and, in particular, those of our activities which are directly relevant to the development of manufacturing industry:

- advice to the Government and to Government Departments on specific technological matters
- research on natural resources and on methods of exploiting these resources
- introduction of new methods and new technologies to New Zealand; these relate more to technologies with wide potential application - "technology-push"
- provision of national testing, calibration and analytical facilities and services - with the proviso that DSIR should not undertake work that could satisfactorily be done by available private organisations
- provision of scientific and technical advisory, and information services to industry; these relate more to satisfying the demands in industry of "need-pull" technologies
- research and special development programmes aimed at building up a pool of skill and knowledge in techniques, processes, and methods of importance to industry with a view to making this knowledge available through advisory services
- provision of special facilities, such as pilot plant facilities, testing facilities, etc.
- making grants, and letting contracts, to universities and technical institutes, for research and development projects, which are important from an industrial point of view.
- funding research associations
- scientific and technical advice to such bodies as the Development Finance Corporation, Consumer Council, Design Council, Testing Laboratory Registration Council, etc.

DSIR does not, in general, do product development for industrial companies. An attempt is made to select programmes which are relevant to a wide cross-section of industry, even through individual firms may be making a wide variety of products.

For example, the technique of numerical control of machine tools is relevant to firms making such diverse products as pumps, cable climbers, tyre moulds, jet boats, brake linings, furniture, etc. The interests of these firms converge in that all can benefit from this particular production technique. Convergences of this kind are profitable areas for DSIR's industrial research efforts.

The Department has special facilities, many of them far more costly than an industrial firm could justify. These can be made available to industry. For example the Chemistry Division of DSIR has pilot plant facilities which can be made available to assist industry to develop new processes involving major chemical engineering plant.

The principal divisions concerned with assisting industry are the Auckland Industrial Development Division, the Physics and Engineering Laboratory, and the Christchurch Industrial Development Division.

RESEARCH ASSOCIATIONS.

One way around the problem of small company size is for a number of firms, within a given industry, to set up a research association and undertake group research for the benefit of the whole industry. There are already a number of research associations in this country and, as a rough guide, they are financed on the basis of a dollar from the Government for each dollar contributed by industry.

In general, research associations do not carry out product or process development for any one company. They are more concerned with the research and development programmes which are of interest to, and are aimed at improving efficiency of, the whole industry.

Their staffs are thoroughly familiar with the industry, its technology, its problems, and its needs. They are, therefore, in a good position to take up ideas appearing in the research literature and to adapt them to suit particular applications, and to provide members of the research association with up-to-date information on developments which are likely to be significant from the point of view of their operations. Further, they enable an industry to undertake research that is impractical for individual companies.

Group research through membership of a research association is an extremely good way of lifting the technological base of an industry, and a very good way of overcoming the disadvantages of small size. Today there are research associations serving the meat, dairy, wool, pottery and ceramics, leather and shoe manufacturing, fertiliser, building, logging, concrete, coal, and laundry and dry-cleaning industry. There is obvisouly room for further development.

The fact that there is an RA serving an industry does not mean that DSIR withdraws entirely from that industrial field. The solution of many problems requires a multidisciplinary approach, and an RA cannot hope to be strong in every discipline. In such cases, DSIR has a role to play in supporting, or complementing, the work of an RA.

Although there are 11 research associations there are many fields not covered by one or other of them, and firms in such areas probably have to fall back on DSIR as their main source of technological support.

UNIVERSITIES.

Universities can make an important contribution to the development of manufacturing industry:

- by performing their principal function of training the graduates who will later enter manufacturing industry in the research and development, and in the management areas
- by carrying out research and by pioneering new areas of technology which can later be exploited by industrial firms, (for example, the polarised ion source, manufactured successfully by the Auckland Nuclear Accessory Company, came as the direct result of research carried out in the Physics

Department of the University of Auckland)

- by undertaking contract research on behalf of industry, or research associations, and on behalf of DSIR or other government agencies.

The letting of research contracts to universities in areas of industrial importance has the obvious advantage that it makes a great resource of skill and knowledge available to industry, and it has the less obvious advantage that by capturing the interest of staff and students in industry's problems, good graduates become interested in industrial research and may later make their careers in the industrial world.

It is very interesting to note that the University of Auckland has created a special office to handle contracts between industry and university staff (the Applied Research Office). One of the important functions of this office is to improve communication between the university and industry.

It can be seen, therefore, that industrialists have a resource of skills, equipment, and knowledge available to assist them. It is regrettable that this resource is very often untapped.

"SUPPORTING SERVICES" INFRASTRUCTURE.

There are a very large number of services which can give valuable aid to manufacturers - particularly to the small and medium-sized manufacturers - to make it possible for them to produce products which:

- more effectively satisfy customer needs;
- make more effective use of available technologies;
- are well designed;
- have been adequately tested.

So that you will obtain some idea of the extent of these advisory services, a small booklet produced by the New Zealand Productivity Centre will be available for distribution. Some of the services which are relevant to this seminar, however, are listed below together with a brief summary of their principal functions. Services will undoubtedly be improved and expanded as time goes by; but you will see that there is developing in New Zealand a valuable core of services to aid manufacturers in their export drive.

Standards Association of New Zealand (SANZ)

(Object: to produce national 'Consensus' Standards)

- standards specifications
- codes of practice
- certification mark scheme

Testing Laboratory Registration Council (TELARC)

(Object: to promote good measurement practices throughout the country)

- assessment and registration of laboratories
- directory of testing and calibration facilities
- assistance to achieve good laboratory practice and management

N.Z. Industrial Design Council

(Object: to promote good industrial design)

- information and advice on product and graphic design
- liaison between those who supply designer services and those who supply them
- evaluation of products for the award of "Designmark" to well designed products

Productivity Centre

(Object: to improve the productivity of N.Z. industry)

- promotion of improved productivity in manufacturing and servicing industry
- interfirm comparisons
- advice on productivity improvement
- productivity groups
- productivity improvement teams

Consumer Institute

(Object: to promote the consumer and promote good products)

- testing and evaluation of consumer goods and publication of results
- evaluation of services to the consumer
- submissions on consumer legislation
- information service to consumers
- consumer complaints service

The Consumer Institute, deserves further comment because its effect on quality control and testing may not be immediately obvious. The Consumer Institute has about 126,000 members (1976), which is 43 members per 1000 of population. This is the second highest membership per capita in the world. 'Consumer' magazine is read monthly by between 400,000 and 500,000 people (in a population of 3,000,000). Products which are tested by 'Consumer' are reported on by brand name and price, and critically evlauated for their performance under the following general headings - safety, efficiency, reliability in use, durability, appearance, convenience, and price. Manufacturers whose products are rated poorly, suffer a significant drop in sales, and make every effort to improve their product so that they will not be caught out' again. If they have not tested their products previously, they certainly will do so in the future. In the 16 years it has been in operation, the Consumer Institute has done a great deal, indirectly, to change manufacturers' attitudes to testing and to quality control. The Consumer Institute does not test industrial products.

DFC Research and Development Finance.

In the 1976 Budget DFC was appointed by Government to administer its programme of incentives for industrial research and development. The new scheme replaces and expands similar assistance previously provided through the N.Z. Inventions Development Authority, Industrial Research and Development Grants Scheme and the National Research and Development Scheme.

The incentives take the following forms:

(1) Project Grants for applied research and development

Grant assistance for specific projects is limited to those costs associated with the applied research and development stage.

A maximum grant level of $10,000 per annum per project has been set, with a limit of $20,000 for any company or group of companies in any one year.

(2) Commencement Grants for the setting up of initial research and development facilities

Where a business has not begun any programme of research and development, an alternative commencement grant may be applied for, to assist in the establishment of a research and development facility. Applicants may not receive both project grants and commencement grants. Applicants must still be able to identify, within their new programme, specific R & D projects having commercial prospects.

An annual limit of $20,000 applies, and a maximum duration of two years.

(3) Investment Finance for all forms of pre-commercial development, excluding basic research.

A variety of forms of investment finance is available covering the whole range of pre-commercial development activity, excluding basic research. That is, such finance may be provided both for applied research and development and for any subsequent pre-commercial development costs. Investment finance is intended to provide a suitable return to DFC, should the project be commercially successful, but not to penalise the recipient should the project fail.

The nature and level of investment finance are designed to meet the needs of individual projects and to reflect the risks involved. Such finance could include:

(i) Equity
(ii) Contingently repayable loans (repayable out of royalties, profits, etc.)
(iii) Joint venture participation
(iv) Finance for trial production runs
(v) Pre-production orders.

AREAS OF WEAKNESS IN TECHNOLOGICAL SERVICES FOR INDUSTRY.

DSIR in particular is a technological resource with skill and equipment that can be used by industry. Some of the services are widely used by industry and are very effective. There are other areas where it is realised that improvements can and should be made - and there are other areas in which we have not clearly recognised, or catered for industries needs (hopefully these will come up in discussion).

Some of the areas which we would like to provide a service or improve existing services are:

(1) Better regional coverage. Our services are reasonably well known and widely used by certain industry groups in Auckland, Wellington and Christchurch, and in some of the larger provincial centres (Hamilton, Palmerston North, etc.); but we are very conscious that we are not serving the smaller centres nearly so well (for example, Gisborne, Napier/Hastings, Dunedin, Invercargill, Oamaru, Rotorua, Tauranga, etc.) and a wider coverage of industrial activities would be worthwhile.

(2) Information Services. Our technical information services are rudimentary. Some encouraging experiments have begun, but they have a long way to go.

(3) Surveys of Industry Needs. Over the past year or two, DSIR has begun "in-depth" surveys of needs in particular areas of industry. These include heat treatment, foundry sands, foundry industry and machine tool manufacturing. Much more needs to be done in this area so that our industrial research effort can be more effectively focused.

(4) Appointment of Technologists to be responsible for a Specific Industry. In the main, DSIR scientists and engineers are grouped in "discipline" laboratories and this arrangement has much to recommend it. There is a good case to be made for the appointment of specialised people responsible for a specific area of industry (foundry technology, metal finishing, etc.).

(5) Publicity. We acknowledge that our capability for assisting industry needs greater publicity, but a much greater demand for service would strain resources.

(6) Formation of Industry Groups. The formation of industry groups to develop research priorities for that group, and to discuss current technological developments and improvements, has been very successful. More effort in this area would seem to be required.

(7) Technological Forecasting. This should be an important DSIR activity and work in this field will be stepped up.

IMPORTING AND EXPORTING TECHNOLOGY.

Any reasonably successful business has two things to sell - what it makes and how it makes it. But the majority of firms simply do not think in terms of selling their "know-how".

Many New Zealand firms "import" their technology from overseas from parent companies; by means of "know-how" agreements with foreign companies or organisations; by membership of organisations which undertake research, and provide "technical intelligence" information for members; and by hiring overseas consultants. Some of the more enterprising firms in New Zealand export their technology by manufacturing under licence and "know-how" agreements.

The principal point of focus for a firm is that having identified a customer need it does not matter where the technology comes from to satisfy that need. Firstly, of course, the appropriate technology must be identified, then it must be developed or acquired. So far in our discussion we have concentrated on development of home-grown technology, either in-house or by a technological support organisation. In many cases, however, it is cheaper to import the technology and adapt it to the local situation. Japan's rapid development owes much to the aggressive use that she has made of imported technology.

If, however, a firms uses licensing or "know-how" agreements as a source of its technology there are some several points which ought to be taken into account in entering into such agreement. We do not claim to be experts in this field, but we "float" a few ideas that we think ought to be considered when negotiating the agreements whether for importing or exporting technology. The list below is written from the point of view of the importer of technology; a similar list with the reverse emphasis would apply for those exporting technology.

1. It is probably a disadvantage to enter into an agreement in which the maximum production is specified under the agreement. Freedom to produce as much of the product as one wishes should be aimed for.

2. It is a disadvantage to enter into an agreement which has export limitations in it. It is true that such limitations may be unavoidable, but one should strive to have the widest "territory" permitted otherwise one's export potential will be severely limited. Some N.Z. companies have entered into agreements which allow no exports at all!

3. Where a "turn-key" operation is involved the agreement should specify a "trouble free" start-up to a specified quality and performance of the product.

4. It is an advantage to have an agreement, in some cases, where the receiver of the technology is provided with staff training. In many cases the licensor will insist on some training so that his technology (of which he is proud), will not be down-graded.

5. It is an advantage to enter into a technology agreement where the technology is actually in use in the parent company, rather than for some technology which is at present unproven.

6. It is advisable, where raw materials quality may be important to the process, to ensure that those raw materials in the "receiver's" country are of similar specification to those in the licensor's country. If not they may have to be imported from the licensor's country; or, to go one step further, it may be an advantage to have the N.Z. company's requirements run with the principal's requirements to overcome the disadvantage of smaller scale operations.

7. It is important for the licensee to satisfy himself that he has -

   a) the ability to produce the new product
   b) the ability to merchandise the new product
   c) the capital, equipment, and talent to reap the benefits conferred by the new technology

   In most cases the licensor will wish to satisfy himself on these points before granting the license.

8. It is desirable that the licensee ensures that he is protected from litigation involving the licensor (i.e. litigation arising, say, if the patent is invalid). We are told that this condition is difficult to achieve in practice.

9. It is important that the life expectancy of the "know how" is longer than the restrictions imposed on the licensee by the purchase.

10. It is sometimes, but now always (see 6 above) a disadvantage if there is a clause obliging the licensee to purchase materials from the licensor as he is then tied to the licensor both in the quality of the materials and the price.

11. It is a disadvantage if the agreement allows the licensor to control, or interfere, directly or indirectly, in the management of licensee's company.

12. It is a disadvantage if the licensee is obliged to transfer to the licensor all improvements, innovations, etc. related to the licensee's product and arising out of R & D on the part of the licensee. If licensee is forced to transfer improvements to the licensor, then at very least the licensee should negotiate for these improvements to attract a royalty

and, possibly, a lump sum, in reverse.

13. It is a disadvantage if the agreement limits the research and development of the licensee - although such a clause would be difficult to enforce.

14. It is a disadvantage if the licensee is obliged to acquire equipment, tools, parts, raw materials, exclusively from certain sources.

15. It is a disadvantage if supplementary technology is forbidden under the terms of the agreement.

16. It is important to avoid excessive "duration" terms.

17. It is worth knowing that patents alone are of little value. Agreements to be truly useful should provide for technical assistance to implement the technology and require information to be transferred as part of the know how agreement.

The most important thing to watch is that the purchaser of technology is not condemned by the agreement, to being utterly dependent on the licensor.

CONCLUSION.

"A unique chronological process involving science, technology, economics, entrepreneurship, and management is the medium that translates scientific knowledge into the physical realities that are changing society. This process of technological innovation is the heart of the basic understanding which the competent manager, the effective technologist, the sound government official, and the educated member of society should have in the world of tomorrow."

Although we have been primarily concerned with technology transfer in this paper, we hold that the most critical ingredient is not technology but it is management. An idea is not an innovation until it is put into use, and that is the responsibility of management.

Management of this company of company is the key to success - management which understands the necessity to hire experienced and high calibre technical staff; management which understands the investment and cash flow requirements of technological development and the time scale and the risks; and management which has good judgement (good personal judgement and good group judgement); management which is innovative.

In short, firms of this kind must have management which thoroughly understand all aspects of the management of innovation. Given this the technical resource of DSIR, the research associations, the universities, and all of the support groups will be used to best effect.

SESSION II

PAPER I

CABLEWAY LOG EXTRACTION TRIALS
GOLDEN DOWNS 1964-1968

R.H. ROBINSON

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A four man crew was engaged in hauler thinning trials at Golden Downs for approximately 4 years and during this period a number of small hauler units were used in various applications to try and find economical methods of extracting thinnings from country considered at the time, too steep for economical extraction with tracked machines.

Most of the initial trials were carried out in Douglas fir areas as there was a reasonable demand for all produce and it was far easier to carry out trials in this species.

A New Zealand Taylor and Andrews, side by side, double drum hauler was manufactured to Forest Service specifications and after some teething problems this unit proved most effective and was operated for approximately 2 years at Golden Downs prior to being transferred to Southland.

Two other haulers were purchased for trials and both were equipped with a V.W. industrial engine.

A 'Krasser' made in Austria was far too light in its general construction and the dog clutches were difficult and slow to engage. The unit was very hard to hold steady and after short trials it was declared a 'FIZZER'. In 1977 it was sent to Reefton to be used for pulling strawline in conjunction with D7 Double Drum winch, at the time it had recorded only 50 hours.

The 'Morito', a winch manufactured in Japan to N.Z.F.S. specifications, proved to be a far superior unit with good controls, line speeds and solid construction which suits the normal heavy handed Kiwi bushman. The unit was also fitted with a capstan drum for endless line operation, but this was not used in trials. The hauler operated for approximately 2 years and has been used only occasionally since the experimental logging section was disbanded to assist in the Wahine Storm salvage recovery.

Trials began in 1966 with downhill thinning and later moved into a small trial thinning from a side hill road then to uphill operation.

The paper progresses through the more important trials where there were both negative and a few promising results but basically to date the value of material from thinning precludes the use of haulers in most areas.

One major system was developed to extract post material and a booklet "Gravity extraction of thinnings from Hill County Woodlots" was published by the N.Z. Forest Service in 1969.

Although the title suggests that this method is strictly for the small woodlot owner, it is considered that multiple use of the system could be instituted by major forest owners when suitable post markets exist.

Copies of this booklet can probably be obtained through the Publication Section N.Z.F.S., Private Bag, Wellington.

DOUBLE DRUM HAULER (Trailer Mounted)

Constructed by	-	Taylor and Andrews
Power Unit	-	Volkswagon industrial engine, 1198cc approximately 12 h.p.
Hauling Unit	-	2 drums, side by side, hydraulic controls - Gearbox with 4 forward, 1 reverse, Hydraulic disc clutch, hydraulic shoe brakes disengage automatically when hauling and hold controls in neutral. Controls - on lever for each drum with forward for free spool, neutral for hold and back to engage clutch.

MORITO HAULER

This unit was designed and manufactured in Japan in accordance with N.Z.F.S. specifications.

Weight:	Approximately 4,000lbs
Motor:	Volkswagon 1500 c.c.
Drum Capacities:	Main drum 1,410' ½" rope Haulback drum 2,670' 3/8" rope

Line Pulls and Speeds:

Half Drum	Main Line	Haulback Line
1st Gear	8,900 lbs 108 ft/min	6,000 lbs 160 ft/min
2nd Gear	4,870 lbs 200 ft/min	3,300 lbs 300 ft/min
3rd Gear	2,690 lbs 360 ft/min	1,820 lbs 530 ft/min
4th Gear	1,480 lbs 655 ft/min	1,000 lbs 970 ft/min

Hauler is also equipped with a capstan, for using endless rope systems, such as a Tyler system. General performance of unit is excellent.

DOWNHILL HAULER THINNING GOLDEN DOWNS FOREST

Brief Description of Equipment and Logging Method

1. Hauler - New Zealand made (Taylor and Andrews) light weight trailer mounted two drum winch. 800' of ½" rope and 2000' of 3/8" tail rope contained on side by side drums. Powered by an air cooled Volkswagon engine of 14.7 rated H.P. Bedford transmission and Wido gear box.

2. Loader - Fordson Major mounted Hiab Elephant with grapple.

3. Power Saw - Canadian 270

4. Radio - Pack portable type P.1

5. Logging Method - Downhill hauling on 25-30° slope. Hauling distances, in compartment 20, from Wellington Gully to ridge top are 10 plan chains and less. The main block is rigged 26-30° up the spar tree giving a high lead but not an aerial logging system.

A nine row strip is treated at the one time, the centre row being clear felled and 4 rows either side thinned.

No special landings are cleared on the edge of the roadway, the total width of which is usually about 25'.

Top hauled tree lengths are dropped across the roadway and extending back into the strip. Tree lengths are then cut to short sawlog length (10 to 20') and mine poles, as logging proceeds. After the strip has been completed the butt logs have to be fleeted up by the hauler and placed on top of the top and middle logs already lying across the road (now completely blocked).

Two more handling operations are then necessary with the Hiab unit. First to turn the logs and stack them parallel with the road and second to load them on to the logging truck.

6. Compartment and Tree Details

The Douglas fir in Compartment 20 was planted at 8' x 8' in 1935. Current stocking is approximately 500 S.P.A. which the prescription required to be reduced to 200-220 S.P.A.

The average yield/per acre to date for 7 acres thinned has been 3,086 cu.ft. Thinnings average 11" D.B.H. with a nett volume of 18.4 cu.ft.

Sawlogs average 6.75 cu.ft. and mine pole material 2.5 cu.ft.

Since the first installation of the experimental two drum hauler some advancement has been made in downhill extraction of thinnings. The hauler which has caused considerable loss of time through mechanical and design failure is now operating well with little time loss through breakdown. The loader (mobile) has caused many hold ups to the job and continues to do so, but to date no alternative unit can be foreseen which will give the same performance under similar operating conditions with any improvement. Time study by Work Study Officer, L.S. King has thrown some light on the costs of respective sections of the work and gives an indication of the aspects which should be studied critically to improve overall cost, and production rates.

The following extracts from the report by L.S. King give an indication of costs under ideal conditions with the trials carried out downhill.

Overall Evaluation of Current Logging Methods

Owing to the fact that the Hiab unit was mechanically out of action, the stacking and loading of logs was not time but this cost, and some other factors as show in Section F, were estimated to round out the picture. The cost ascribed to loading could well be underestimated under the prevailing methods.

Cost and output are summarised as follows:

Work Phase	No. Men	Cost/Cu.ft.	Cu.ft/Manhour
(a) Felling	1	0.34d	
(b) Hauling	4	6.08	41.75
(c) Fleeting	2	0.37	
(d) Rope Shift	3	0.45	
(e) Hauler Shift	3	0.19	
Total (a to e) Bush		7.43	32.9
(f) Estimated other costs		3.20	
Direct cost on truck		10.63	
Overheads		2.44	
Possible Total Cost		13.07d	

For the portion of the job time studies, i.e. (a) to (e) above, the direct cost is calculated at 7.43d per cu.ft. at an overall output of 33 cu.ft. per target manhour. In assessing this cost it has been assumed that 12½% of the available productive time would be lost due to downtime which would give a departmental output of 29 cu.ft. per manhour.

This cost and output summary appears most promising but it must be realised that the figures used for this summary are based on a small area (approximately 1 acre) and were taken under favourable conditions for downhill hauling.

UPHILL TRIAL TO SIDE SLOPE ROAD. (Cpt 32)

A short trial was carried out with the Taylor and Andrews hauler thinning Douglas fir to a restricted side hill road with no skid site. A normal rope circuit was run but a spar was considered unnecessary as there was sufficient lift to stockpile the logs with the height of the road cutting above the road. Logs were generally prepared in the bush then pulled and dropped across the road. The mainrope was arranged with an end section of approximately 3 chain which was connected with a double eye which could pass through the block. After hauling to the road the log was then connected by a C hook to the double eye and rehauled and dropped into a stockpile against the bank, (see Fig. 1). This system allowed the road to be kept open and was feasible to work solely with the hauler unit to stockpiles for later loading out.

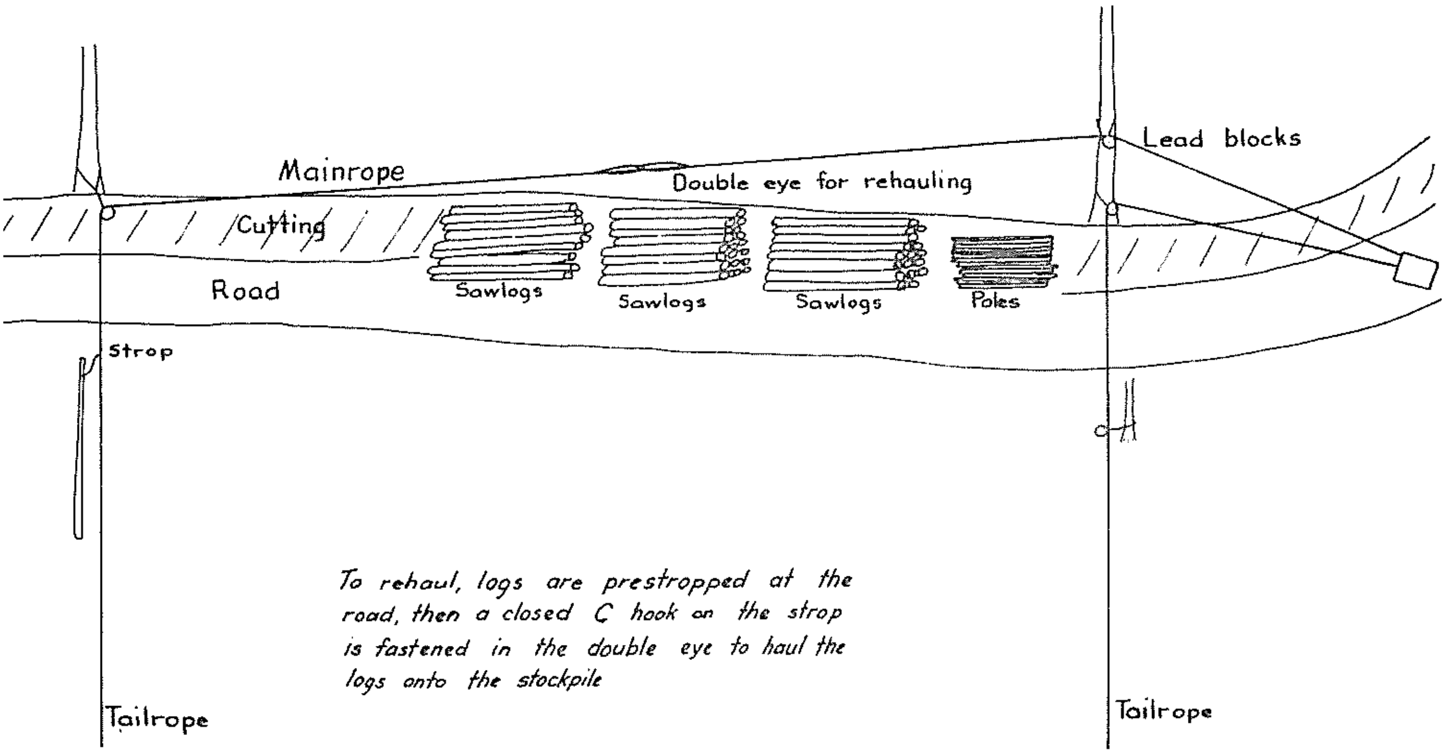


FIGURE 1

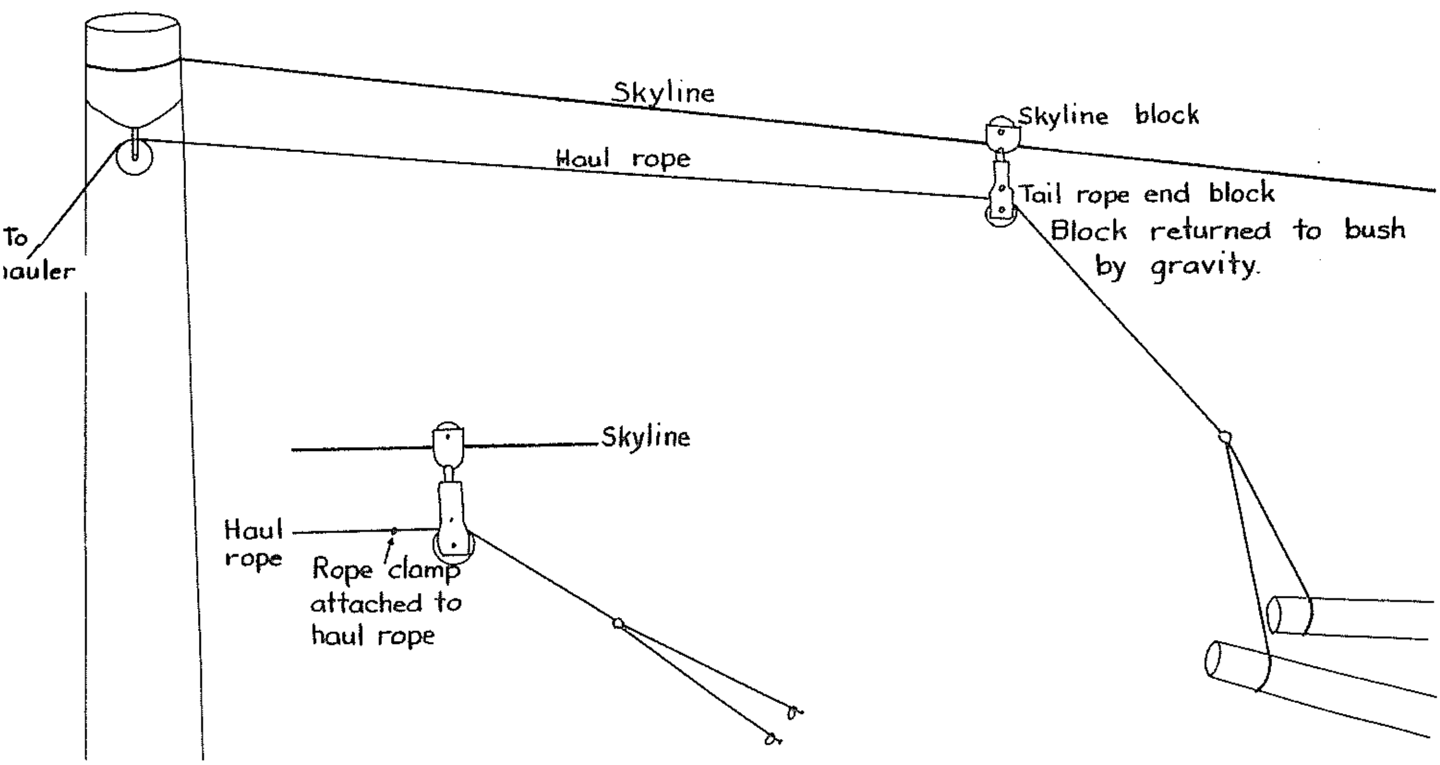


FIGURE 2

Because of the rehauling and double handling of the logs, this system slowed hauling times quite drastically.

GRAVITY RETURN HAULING TRIALS - Uphill

It has been shown previously that thinnings can be extracted downhill under favourable conditions with a light hauling unit. The current experiments are now aimed at extracting uphill from moderate to steep country.

The trials began with the idea of extracting full length thinnings up to a ridge top road using a simple ground hauling system. As in all previous trials, the skids or landing area proved a difficulty and a simply system of turning tree lengths parallel to the road was adopted. This method overcame the time consuming rehauling and stockpiling which was essential with previous downhill experiments.

After a short trial it was found unsuitable to ground haul and turn the tree lengths as the ropes often endangered the skiddy and the set up was changed to haul log lengths.

A short spar (8 to 10ft.) was rigged to haul and stack the logs across the road. A further short trial showed that the skiddy was still working under the ropes which often dropped very low on the log heap. To overcome this a higher spar was raised (approximately 30 ft.) and this was found quite satisfactory from the safety angle and also allowed more lift to the incoming logs. Various rope systems were tried and the results of these were as follows:

(a) High lead with a system using the tailrope and block for side hauls into the haul track as carried out down hill previously. This worked but the log lengths being pulled into the haul track often swung about violently and caused considerable damage to the final crop trees. If logs jammed where there was little effective lift from the high lead, it was difficult to pass an obstacle by tail-ropping then hauling as they returned to the same obstacle each time.

(b) These two serious problems led to a trail with a skyline and this was set up (see Fig. 2) to give lift to the front of the drag and to hold it in the haul track. The rigging was carried out by leaving the tailrope round the circuit and attaching the end onto the top of the spar at the skids. A block (with a counterweight to hold it upright) was then put on the tailrope, or skyline as it now became, and the tailrope end block was hung underneath. The mainrope was passed through the lower block and the strops were shackled on the end. The butt rigging gear was then returned to the bush by gravity and stopped by using the mainrope brake. Clearance was obtained by taking the low end of the skyline (tailrope) across a small gully opposite the haul strip. It was obvious after the first few hauls that this system was not satisfactory as the skyline block would travel well up the ropes away from the drag and the lifting effect was lost.

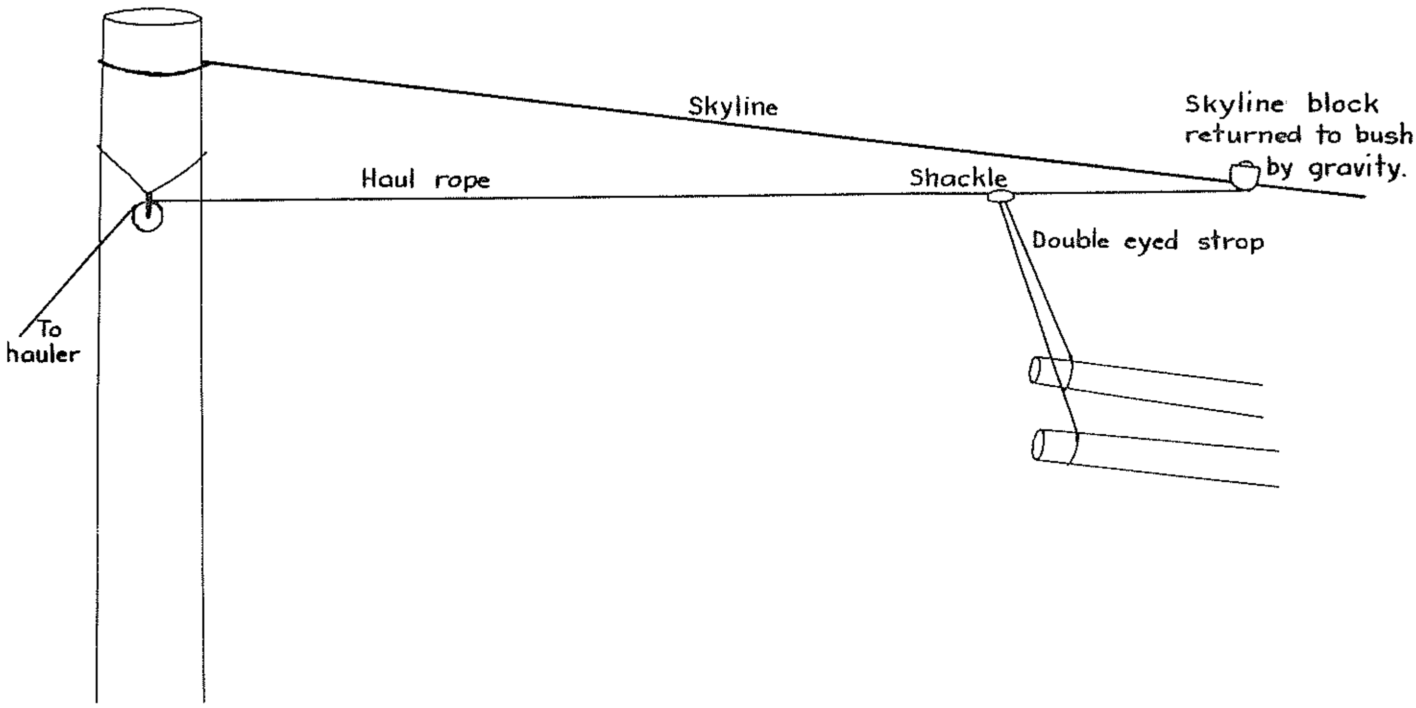


FIGURE 3

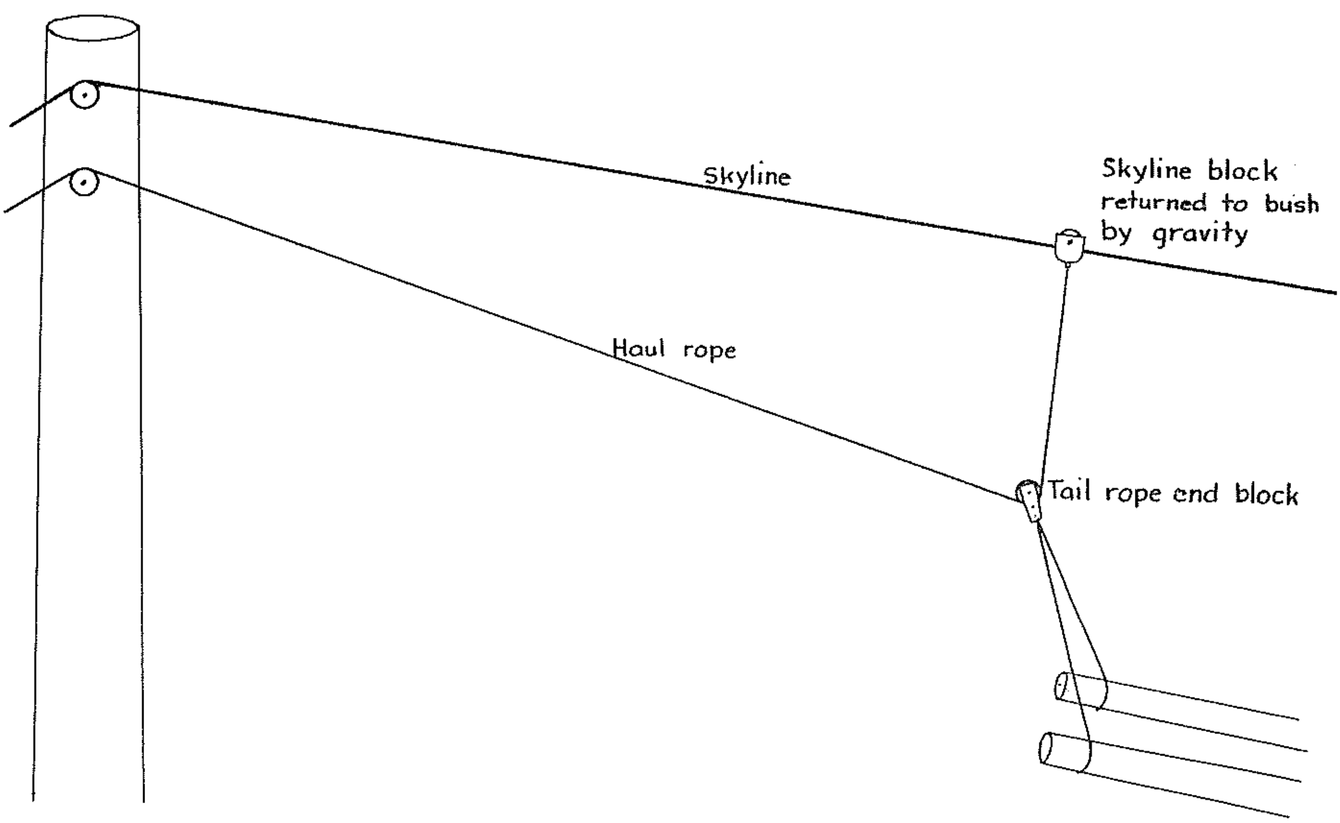


FIGURE 4

(c) To counteract this a rope grip was clamped to the mainrope (see Fig. 2 insert). This prevented the block from travelling away from the load but it also prevented the drag from being hauled right up to the pole and this was essential on a narrow ridge top road. A further difficulty arose when the drag jammed and the increased rope tension forced the rope grip to move along the rope causing severe rope damage.

(d) The system was further altered (Fig. 3) and this allowed reasonable landing at the pole but hampered breaking-out and hauling.

Clearance had to be more than the short section of mainrope beyond the strops to give any effective lift and there were more tangles with the ropes and strops arriving in the bush which slowed breaking-out times.

(e) A further alteration using a modified North bend system was then set up and trials are being carried out using this method (see Fig. 4). The mainrope has now been run through a block at the top of the pole and anchored with a little lift at the lower end of the haul strip. This is now used as a skyline and can be slackened or tensioned as required with the hauler controls. Through these trials with a skyline, gravity has been used to return the strops to the bush and this appears to be most satisfactory if the line clearance has been obtained by anchoring the lower end across a small gully. This will not be possible in many situations and it is intended to use a tail tree as required in other areas. The hauling strips originally were approximately 9 rows wide and it appeared that the best hauling results can be obtained by reducing this to about 6 rows. It will become more important to shift from one stand to the next with a minimum of delay, and this problem is being studied currently. Raising a spar and rigging has taken considerable time and if only 6 rows are to be thinned per shift then this rigging time must be reduced to a minimum. To facilitate faster rigging it is intended to construct a pole rigging clamp which can be clamped to the spar prior to raising and to which all the guys and the skyline block can be attached.

A special rope clamp has been constructed to speed up guy tightening which has taken much time to date. Tests with this will be carried out as convenient.

SOUTH BEND UPHILL THINNING TRIALS

Previous uphill hauling trials have not been very successful. Gravity skyline and high lead systems were employed but all had one disadvantage - a very limited amount of reach from the haul track. With the limited amount of produce extracted to each setting, the frequent shifts and very high rigging time killed the feasibility of economical uphill extraction.

SOUTH BEND SYSTEM - UPHILL HAULING

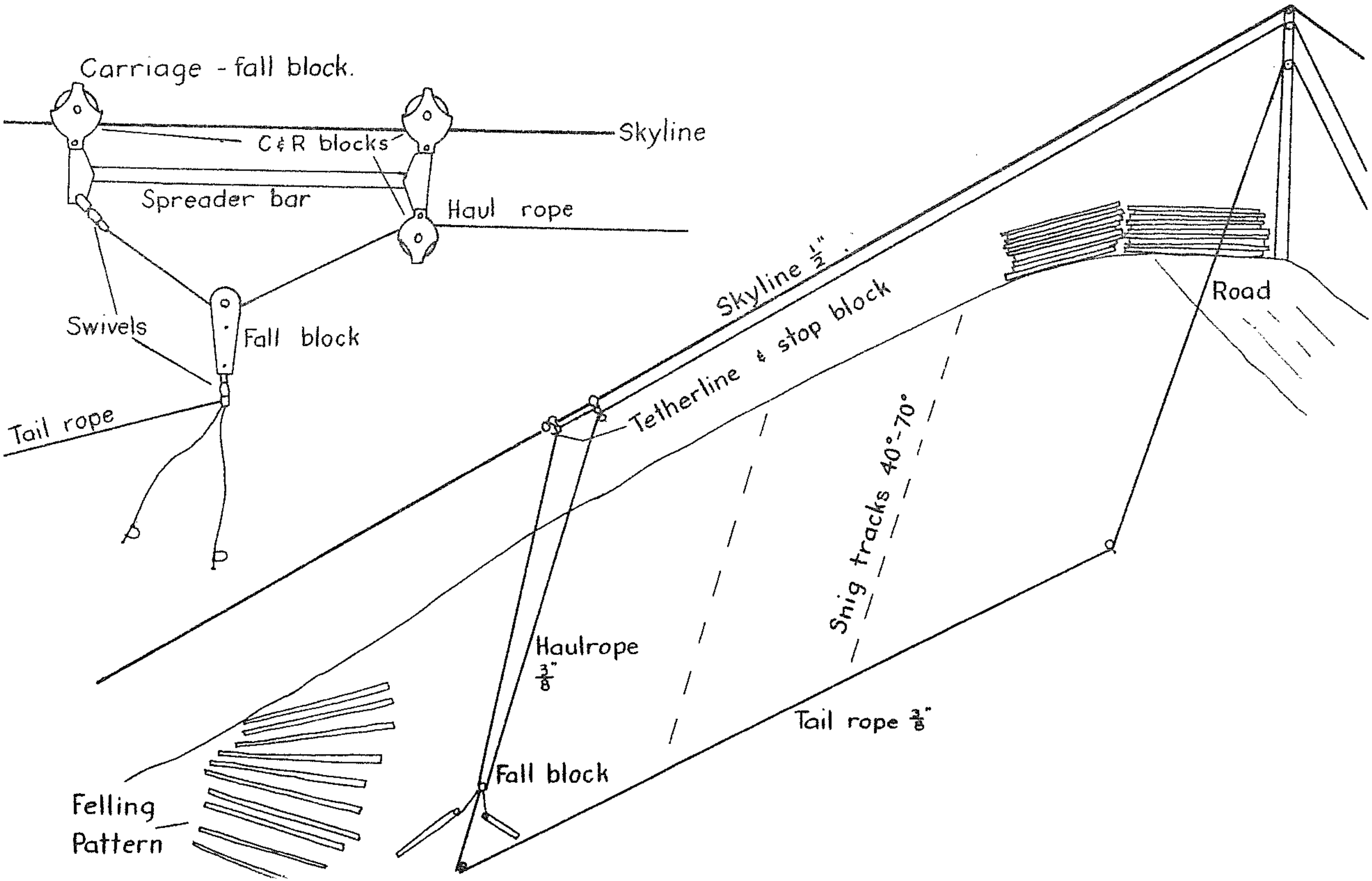


FIGURE 5

Rigging is very difficult on narrow ridge roads. This is due to lack of height for the lifting rope, and the very long and heavy spars (40') which are required to give clearance above the ridge crown.

Lack of landing space prevented the working of several strips (radial hauling) to each setting, but this was partly due to the loader, which has a limited amount of reach, preventing the cold decking of logs off the ridge road.

Felling times were also very high. Trees were cut to log length in the bush and an extra man assisted the crosscutter, measuring and trimming.

At present a system is being initiated which is overcoming most of the problems mentioned above. Up to 3 chain has been worked to a single haul track and the distances can be extended. Trials will be carried out to determine maximum hauling width.

The system employs a South bend rig, using a modified carriage and a fixed skyline (see Fig. 5).

Carriage is made up using 3 C and R trip blocks and an axle shaft 4' x 6" long, with attachment fittings welded at both ends. Two travelling blocks support the bar, with the third block hanging underneath, on the haul end. The haul rope is passed through this block and attached to a swivel at the rear end.

A fall block is positioned on the haul rope under the spreader bar. This was also made up using an 8" pulley. Side plates are 18" long. Strops and tailrope are attached to the fall block.

Both haul and tailrope are 1/8". Initially ½" haul rope was used but it was found too heavy with the purchase, and gave no safety margin between it and the ½" skyline.

First Installation

A fixed skyline was rigged on an 8 chain track, long enough to allow one end of the haul to drag. Skyline track is approximately 8' wide.

Hauling face was pre-felled up to 1½ chains from the main track. Initially felling was parallel with the main track, but it was found later that if felling is directed towards it, at right angles to the snig tracks which herring-bone from the skyline, line shifts can be reduced and a heavier concentration of logs is possible. Correct felling procedure has not been determined yet, but the method above has been the most favourable to date. Cutting to logs is carried out by the breaker-out while hauling - normally trees are only cut in half.

Initial hauling was carried out returning the gear by gravity. The carriage was stopped by a tethered block on the skyline and momentum lowered the fall block. The fall block was found too heavy to drag any distance so the tailrope was attached. The tailrope is run along the hauling boundary, across the proposed snig track and attached to the fall block.

Finding a suitable tailrope block at the main track was a problem. An automatic trip block was tried but was unsuccessful. It was hoped that when the carriage reached the stop block, the fall block would release the pre-loaded trip block, allowing the gear to be tailroped away from the skyline. This did not work, and it meant holdups in the hauling if blocks were to be used. As no weight is required on the tailrope until the carriage has reached the stop block, the idea of using blocks was discarded, and now the tailrope is left running free. Tree damage and rope bind is practically nil. 'Buffer' trees are now being left when felling at each snig track and these are removed on completion of the track.

On completion of snig tracks the tailrope is disconnected and relayed as the drag continues to skids. When the stop block has been re-set the gear is returned by gravity and reconnected.

Snig tracks are from 1-2 chain apart and angle from the skyline between 40°-70°.

The South Bend system is excellent and offers many advantages over previous systems.

The carriage will not move until the fall block has struck the spreader bar. The fall block stays at the carriage unless the haul rope is slackened.

The purchase enables the use of lighter haul rope and eliminates binding on forward trees - a disadvantage with North Bend and high lead systems in thinning operations.

The 4'6" spreader bar is necessary to stop the fall block twisting - this becomes more frequent as the distance between block and carriage increases. A swivel attached to the fall block allows the block to untwist.

The last area being worked to the one landing is creating a stockpile problem. Logs are being cold-decked below the road, and if a crane loader can be made available, there will be no loading problems, and no necessity to stockpile. With such high rigging and slower rate of production, uphill hauling cannot be governed to suit loading conditions, such as in the past, if a reasonable output is to be realised from each setting.

The Morito hauler with its extra horsepower has brightened prospects considerably. The T. & A. unit is underpowered for uphill extraction, and even under excellent hauling conditions, it was doubtful whether it was capable of attaining an output at a reasonable productive level.

Rigging and setting up problems are being overcome and times and difficulties have been eased considerably.

A small clear felling trial was also set up using this same carriage unit and hauling downhill. This was carried out in Compartment 52, P. nigra and was moderately successful, but only 1 acre was cleared. A diagram of the layout is attached as Fig.6.

DIAGRAM SHOWING CLEARFELLING ORERATION
COMPARTMENT 52
SYSTEM: SOUTH BEND & FIXED SKYLINE

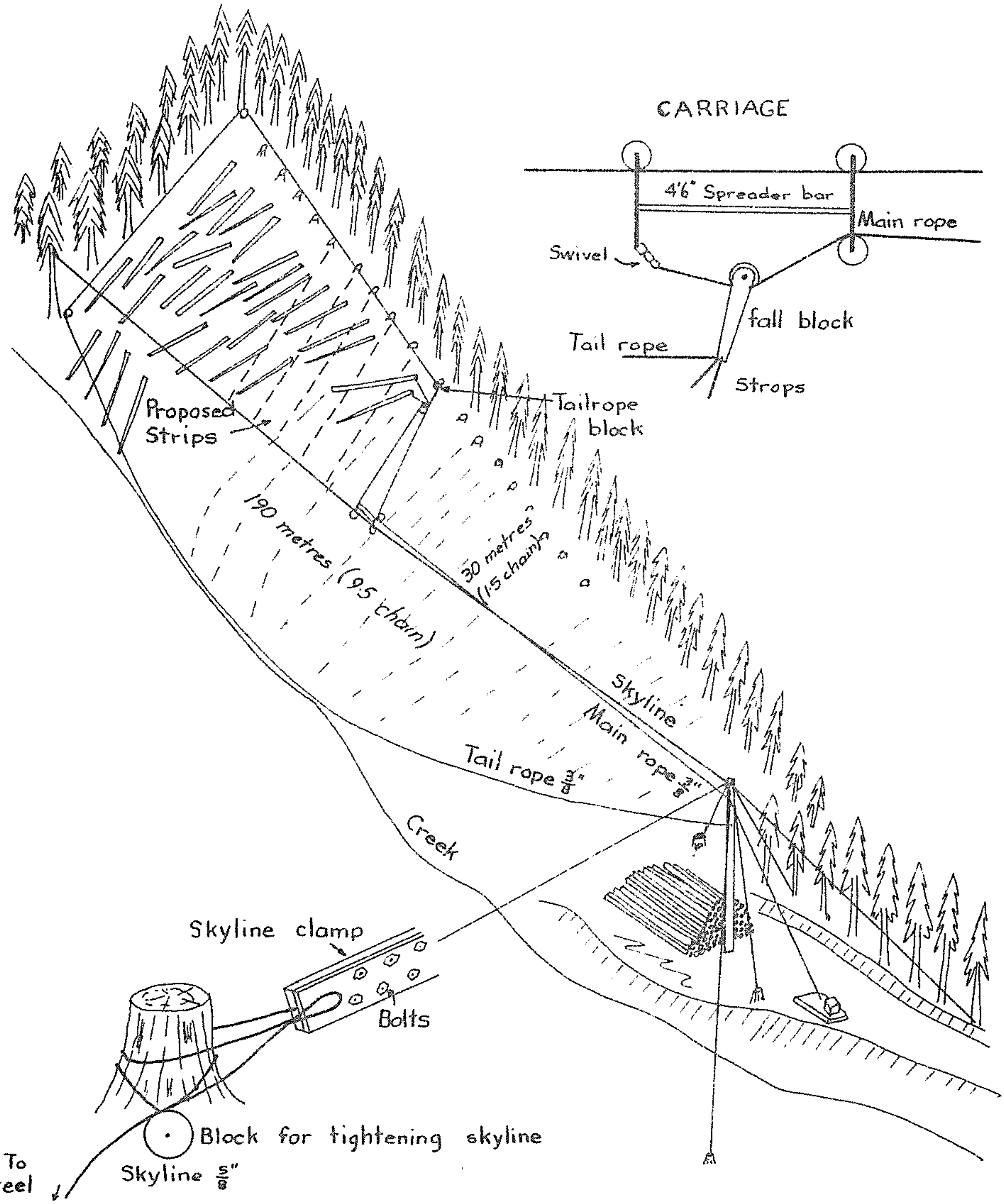


FIGURE 6

SUMMARY OF SOUTH BEND THINNING TRIALS

Uphill trials in Compartment 41 have been completed. All suitable areas in this compartment have been thinned, and the Morito hauler is to be released to workshops for repairs and modifications. Further trials will be carried out when arrangements can be made for a time study, by a Work Study Officer. Meantime, the Experimental gang will concentrate on post and minor produce extraction using the Krasser winch, and explore the possibility of wire skidding.

The South Bend system has been quite successful, it has enable large areas to be worked to a single setting, offsetting the very high rigging times and frequent shifts experienced with earlier systems, and it has been possible to work varying topography, a limiting factor with most of our earlier hauling methods. A total of 4.7 acres were hauled to 3 settings.

The following report covers the operation dealing with the limitations, etc., and what has been achieved with this system.

Felling

Felling is very important and hauling is largely governed by the pattern and standard of cross-cutting. Poor directional felling resulted in lengthy delays and heavy tree damage. Unlike downhill hauling, where it is possible to pattern a wide face of felling to a single point for hauling, haul ropes must be taken to the timber, to extract uphill. As hauling is confined to the snig tracks it is extremely important that logs are within reach. Without means of pulling slack, ropes have to be re-run to pick up stray logs. Trees felled parallel with snig tracks usually gave this problem.

Various felling patterns were tried, and an attempt was made to concentrate felling, such as with the downhill hauling pattern, onto cut snig tracks. Only one pattern suited hauling and the latter method was a failure. With no direct pull, and considerable give in the skyline, too much strain was being placed on the ropes. Logs were often too heavy, and if they had to be cut, the remaining section could not be reach withoout difficulty. Fouling and tree damage increased. Again, poor felling, particularly with insufficient angle, gave serious problems. Hauling of full length logs is not satisfactory, not only from the bush end, but also at the skids where landing space is very limited.

Felling trees at right angles to the snig tracks has given the best results. Little attention is paid to positioning of snig tracks, unless they are particularly obvious, such as large gaps. The whole face is pre-felled. It is preferable to fell and haul one side of the skyline before felling the other, to keep slash to a minimum. The skyline track is approximately 1ft wide, and the bordering rows are left intact. Trees are used as buffers at the corners of snig tracks to protect the remaining stand; these are removed on completing of tracks. It was also desirable to leave trees unsuitable for produce standing, to be removed later by the breaker-out. These were often useful in protecting the final crop, and running ropes around. Nothing more is done at this stage to the timber; cutting of logs is carried out by the breaker-out during hauling.

Rigging

It is preferable to keep the skyline at a height which will allow one end of the stropped logs to drag. Approximately 30' is a good height. The carriage holds the drag up, and if logs become airborne the resultant swinging damages trees bordering the skyline. The skyline was anchored on the opposite face for 2 strips, but a tail tree was required for the third. A light Japanese block and one 3/8" guy was used, rigged approximately 25' in height. When shifting strips the skyline is changed end for end by running the tailrope down the next track, through the tail tree block (or around anchor stump) and grommeting the two together. When through the lead block, slack is taken up either with the capstan (Morito only) or the runabout.

Previously the skyline was tensioned by clamping a shackle to it, fixing a block to the anchor tree, and using the main rope. Extra blocks were often required for purchase. Purchase blocks (4-1) and nylon rope are being used successfully; these are only prototype units, so tests will be carried out to determine the most suitable purchase required. It may be possible to pre-rig and tension skylines with a runabout. An excellent feature with supporting the skyline with pulleys is that sag can be removed very quickly; previously a time consuming job.

Working at right angles to a narrow road creates a problem with the hauling rope. If run directly from the hauler to spar, bight is formed in the rope. This places too much strain on spar and guys; both have been snapped as a result. Lead trees behind the spar, in line with the skyline were used, but it was not always possible to find suitable trees. This can be overcome by positioning the spar in a shallow hold for support and placing the lead block at the base. Mainrope is run up the spar to the top block. This will overcome severe changes in angle without overstraining guys.

Tailrope is circuited around the felling boundary and across the proposed snig track. The stop block is tethered opposite the snig track, and the fall block is returned with carriage by gravity, to connect with tailrope. If the skyline is pulled away from the hauling face and held with the stop block, it will not bind against the bordering row when under strain. Working from the top of the strip down is preferable, to avoid slash, but it requires running the tailrope in a circuit around the hauling area, if pulling extra slack is to be avoided each time snig tracks are changed. On completion of a snig track the tailrope is disconnected at the stop block, and relayed while the drag continues to skids. Gear is returned on re-positioning of stop block.

The most economical width for strips is not known, but snig tracks should not exceed 3 chain. Slope will be the main determining factor, as this governs the angle of haul, which in turn will limit the width of the strip. Long snig tracks, as well as giving more problems, increases line shifting times considerably, so a balance will probably have to be sought here too by time study, to ascertain the overall economical hauling distance.

SKIDS

Skids, despite the large volume of timber being amassed, did not give any major problems. Logs were stacked off the road when the stack became too high. Such an operation on a productive basis cannot be governed by skids, which has bound these operations down in the past, if production is to be maintained. Logs can be stacked below the road with little difficulty, and will not post any loading problems if a suitable loader is used. A mobile crane type of unit would be excellent, eliminating the need to stockpile, which is only required for the present loaders because of its limited reach. Most of the produce is cut in the bush and the skiddys task is limited mainly to unstropping and trimming. Minor produce, such as poles etc., cannot be handled without great difficulty, particularly with a high stack, so all produce has been limited to sawlogs.

Personnel

The whole operation can be carried out by 3 men. Four men were used for the trials, one as a whistle boy, using a field telephone, the talkie tooter was out of action. The talkie tooter was used for several days very unsuccessfully, the whole operation being controlled by whistle signals only.

The first two strips, like all previous uphill trials, were on a relatively flat face, hauling against the grade. On the third installation, the skyline was sited down a gully, and all timber from the ridge was extracted to it. This system is more suited to these conditions, than a flat face. Weight could be maintained between the skyline and tailrope block with the full block. This kept the gear clear of the ground, preventing the fall block from twisting, and strops from being entangled. It also gave better control over the drag, particularly if weight was applied to the tailrope when hauling in. The hauling grade on the skyline is decreased. Felling is also easier, as it is directed more or less with the slope. Gullys give ideal hauling conditions for this particular system.

Ridge roads, offering few handy anchor stumps, makes the tieing back of haulers very difficult. Very long tie-backs are required, giving little stability to the hauler and extra supporting guys are usually required. Not a satisfactory arrangement of the Morito, which is very unstable at the rear. This was overcome by positioning the unit in the centre of the road, passing a rope over the rear runners at right angles, and anchoring both ends each side of the road.

Shackles held the rope to the hauler attachments. Fleet angle was obtained by attaching the 'Tirfor' to the hauler, clamping the 'Tirfor' rope to the tie-back and sliding the rear of the unit (see Fig. 7). Two large 'norved' type clamps each side of the runners held the hauler fast to the tie-back. This method of anchoring is very stable.

Towing the hauler is normally carried out with the loader, the unit being too heavy for a vehicle. However it became necessary to do so when the loader was unavailable, using the runabout and blocks for purchase. A system called the 'Burton' purchase was employed, using 3 blocks and a length of strawline, giving a 6-1 purchase. The hauler was towed along the road with ease (see Fig. 7). The 'Burton' purchase is very useful and its application on hauler operations is manifold, particularly so for raising of heavy spars.

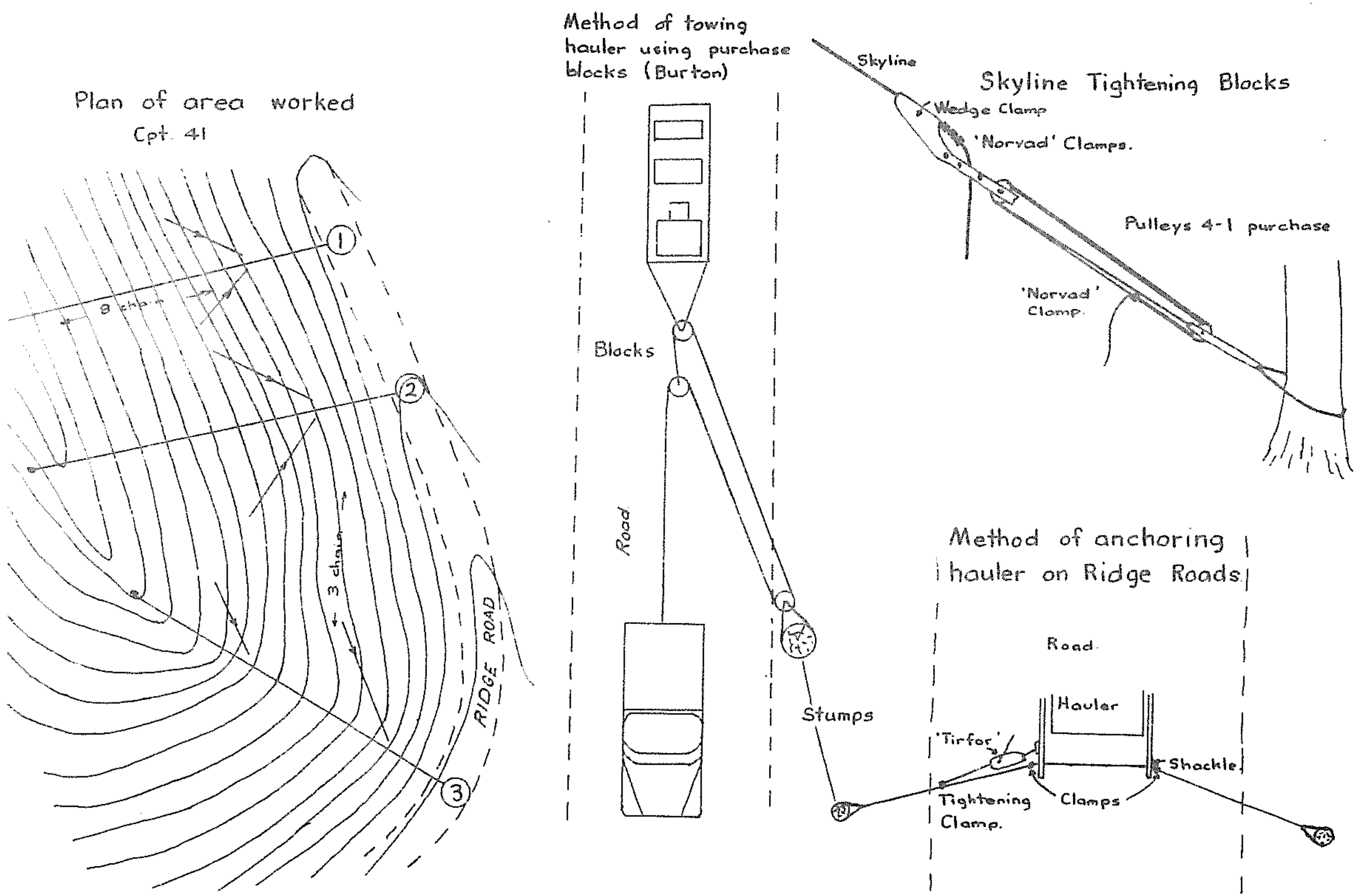

Plan of area worked
Cpt. 41
RIDGE ROAD
8 chain
3 chain
Method of towing hauler using purchase blocks (Burton)
Blocks
Road
Stumps
Skyline
Skyline Tightening Blocks
Wedge Clamp
'Norvad' Clamps.
Pulleys 4-1 purchase
'Norvad' Clamp.
Method of anchoring hauler on Ridge Roads
Road
Hauler
'Tirfor'
Shackle
Tightening Clamp.
Clamps

FIGURE 7

This system has given the most favourable results for uphill extraction to date. The system functions very well, and there seems little that can be changed, or improved upon basically. Times for shifting tailrope when changing snig tracks will have to be improved on. This can be time consuming, often taking 15 minutes or more on long snig tracks. The desirability of circuiting the tailrope around the haul area is that extra rope is not required with shifts. Being only a 3 man operation, strawline is required to pull the tailrope around the area. It may be quicker overall if the tailrope were run directly to the first snig track, and pulled out with each shift, light strawline; nylon rope or possibly aircraft wire on a reel, could be run over the next snig track perhaps during lapses in hauling, and attached to the tailrope, which would be disconnected at the back block. Tailrope would be pulled around with carriage, the strawline being attached to fall block, and the strawline would be pulled or wound in as the carriage is returned. A solution to this problem is not definite, and further trials will be required, but the present method will probably have to be changed as it does appear too slow.

Pre-stropping would have been advantageous, and would have speeded breaking out times considerably. A lot of time was wasted untangling strops; pre-stropped this could be done during haulings. It would also have permitted reaching difficult logs by joining strops together. Special chokers (screwy) will be required. The ordinary type were experimented with but were unsuitable.

One final point. Some means of stropping tailrope blocks other than with wire strops must be sought. As one boundary is normally against a thinned area, final crop trees are being damaged by the tailrope block strop. These have to be used being outside the felling area. Most other areas where various trials have taken place have remaining crop trees which bear evidence to this problem. A wide type of belt, similar to the tarylene safety belts could possibly overcome this. However, some solution to this will be needed for future thinning operations of this nature.

SESSION II
PAPER III

LIRA CABLE LOGGING RESEARCH INVESTIGATIONS

V.F. DONOVAN
Research Officer,
LIRA.

Introduction

LIRA has given priority to cable logging research after extensive discussions with the industry throughout New Zealand. It became obvious that detail on harvesting systems and machine types required for the significant areas of plantation forest already planted or future areas for establishment was concerning many people in the industry. The need for increased yields off steep country through thinning and the probable clear felling of smaller tree volumes has and will require a revision in thinking from the conventional cable logging practices in this country.

There has been a general loss of skills in the art of cable logging during the past decade both in managerial and operational aspects. Many people thinking of cable logging for the future have a limited knowledge of equipment systems, planning and technical detail on which to base decisions.

LIRA's objectives in cable logging research in the first instance are thus directed at improving and co-ordinating the current state of knowledge.

Cable Logging Research Objectives

To guide machine and equipment selection specifically in the use of units suitable for smallwood harvesting and thinning.

To educate and present facts on equipment, methods and operating detail with the aim or increasing the awareness of problems and the necessary skills to overcome them.

To improve techniques suitable for application in thinning and clear felling for New Zealand conditions.

Research Programme

Working Group

A cable logging working group was formed by LIRA to ensure that there was close co-ordination between other interested parties working on research in this area and to discuss the direction, aims and objectives of their research programme.

LIRA's cable logging research is being directed in three main areas to thus achieve the objectives stated.

1. Extension

   Seminars

   This Cable Logging Seminar was organised as the first step in attempting to discuss fully the art of cable logging and the many implications involved for the future. Assistance on the format and programme of the Seminar was given by the cable logging working group. LIRA anticipates that this forum will help in not only fulfilling the seminar objectives but also highlight other areas where the research effort should be directed. Other technical sessions on cable logging will be organised in the future as the need arises.

Handbook

Currently under preparation is a cable logging handbook which is primarily aimed at supervisors of hauler crews, those involved in the planning of hauling, and operational management. The handbook is one step towards improving the efficiency of cable operations and should be particularly useful in the smaller enterprises.

Model Hauler

A small model hauler is being modified and developed for use of system demonstrations. It could also be used to attempt to establish the various stresses and strains imposed on ropes or other hauling components during various method or techniques.

2. Present State of Knowledge

Hauler Survey

During the latter part of 1976, and in 1977, LIRA conducted a survey of cable logging machines operating or available in New Zealand. The objective of the survey was to collect background data on machine characteristics and the conditions under which they were being operated.

Details which included machine make, model, initial costs, basic specifications, rope, rigging and ancillary equipment was collected. Also operating detail and the crop terrain factors, haul distances, annual production, etc., was gathered. This information supplemented more general data collected by FRI in an earlier survey.

A summary of the LIRA survey covering machine and ancillary equipment is attached as Appendix I to this paper.

Machinery and Work Method Evaluations

To date evaluations have been conducted on some of the newer small sized haulers with comments on the method of operation. Unfortunately several machines in this category have not been demonstrated or operated in situations well planned to best indicate that machine's potential.

Two machines so far covered in this series are Timbermaster skyline hauler, volume 2 number 3, 1977, Madill 071 mobile yarder, volume 3, number 1, 1978.

Further evaluations covering machines such as the Ecologger and Wilhaul will also be carried out.

Cable Logging Questionnaire

A questionnaire was recently circulated to all forest owners and logging companies throughout New Zealand, for information on the future size and scope of cable logging.

The questionnaire was basically in four parts:

Part 1: Gross area figures by age class.
Soil and slope categories by area.

Part 2: Criteria for cable logging selection.
Total cable logging areas.
Current hauler status or proposals.

Part 3: Cable logging programme over 5 year periods.
Advanced planning and roading programmes.

Part 4: Important ratings for factors as machine selection, costing, production, labour techniques, etc.

A total number of 37 questionnaires were sent out and 22 number (59%) responded with a reply. A number of organisations, (mostly afforestation trusts) indicated they were not yet in a position to answer such a questionnaire.

3. New Equipment and Techniques

Research to date has highlighted areas of existing operating procedures and systems where significant gains in operating efficiency could be made.

A review of relevant study data and literature showed that breaking-out takes up a significant proportion of each operating cycle. (Data from 17 operations indicated an average 33% of cycle time is in breaking-out with a range from 10% to 58%).

Means of overcoming some of this delay could be in adopting gravity return systems and the use of different types of carriages.

Carriages

New types of carriages not common to New Zealand have recently become available. These include:

A slack-pulling carriage which incorporates a lifting line.

A gravity return carriage which incorporates a skyline clamp and stop, the ability to pull slack and to lock in the main rope.

LIRA is to initiate studies where these carriages can be fully evaluated and techniques for their use analysed.

Thinning Equipment and Techniques

Many things can influence productivity on a cable hauling operation. Two of the most significant factors are:

Log size: Each log must be hooked and unhooked. More chokers will increase haul volume provided it is within the capacity of the machine but this will also increase break-out time.

Volume per
Hectare: This affects the unit charges such as roading, rope shifts and setting up time. The greater volume per hectare available for extraction, the less the unit charges per cubic metre logged.

The fact that tree volume and volume per hectare are both limiting factors in a thinning operations, LIRA considers the basic criteria in the design of a small skyline yarder should be:

Low capital cost
Low operating and crew cost
Simplicity for maintenance and repair
Reliable and versatile

LIRA's research will include evaluation of machines being developed for thinning applications, also to examine cable logging systems and techniques for the extraction of smallwood thinnings on steep slopes and to develop improved methods.

Attachments:

Appendix I - Cable Logging Equipment Survey
Appendix II - Relevant Literature to Cable Logging

SESSION II
PAPER III
APPENDIX (i)

CABLE LOGGING EQUIPMENT SURVEY

During the latter part of 1976 and in 1977 LIRA conducted a survey of cable logging machines operating or available in New Zealand. This survey was part of a broader cable logging research project currently being undertaken. The objective of the survey was to collect background data on the existing state of cable logging in New Zealand, particularly machine characteristics and the conditions under which they were being operated.

This brief report summarises the main machine characteristics and some of the auxiliary equipment.

SURVEY PROCEDURE: Data on each machine and its auxiliary equipment, its productive capacity and work environment were compiled. The survey was conducted as machines or localities were visited in the course of LIRA field trips. Full details were not available for all machines.

SIZE OF SURVEY: A total of 54 machines were surveyed consisting of 35 machines operating in exotic pine and 19 machines in indigenous forest operations. No detailed information was gathered on three of the exotic machines and eight of the indigenous machines.

This survey supplements data collected by F.R.I.* on the size and structure of cable logging in New Zealand when 28 units operating in exotic logging and 43 in indigenous logging were surveyd.

TYPE OF SYSTEM:

EXOTIC OPERATIONS: All machines were operating on clearfelling except one involved on thinnings. *FIG.1* indicates the extent to which different systems were being used.

All the machines operating on a highlead system had three drums except one with four drums. Alternatively the skyline machines all had four drums, except one three-drum machine set with a fixed skyline. Running skyline systems were being operated on the larger three-drum steel spar mobile Madill machines.

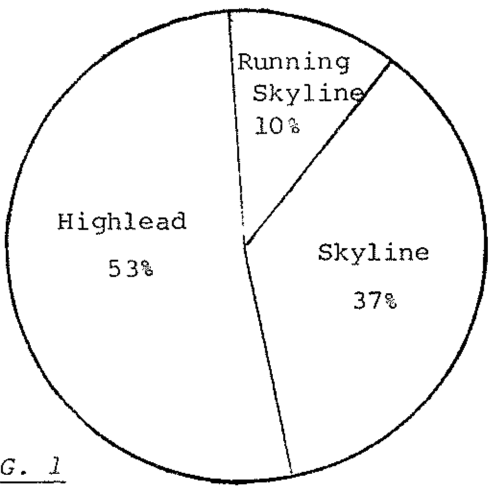


FIG. 1

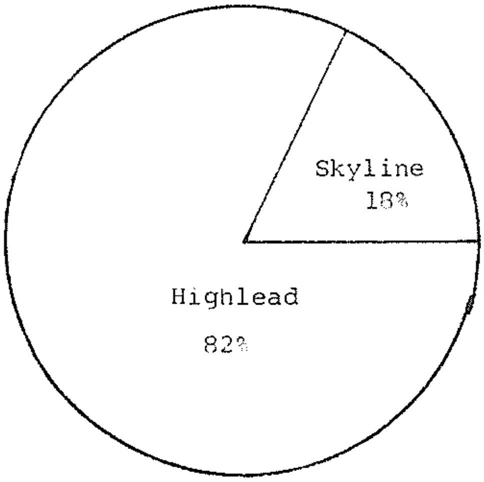


FIG. 2

INDIGENOUS SYSTEMS: Over 50% of indigenous operations used highlead as indicated in *FIG.2*. The new indigenous forest policy of partial or selective logging limits the use of conventional skyline systems particularly North Bend which had previously been used to knock over residual scrub species prior to burning and replanting.

* *"Cable Logging in the Exotic and Indigenous Forests of N.Z." by Murphy, NZFS, Forest Research Institute Economics of Silviculture Report No. 89, 1976, (Unpublished).*

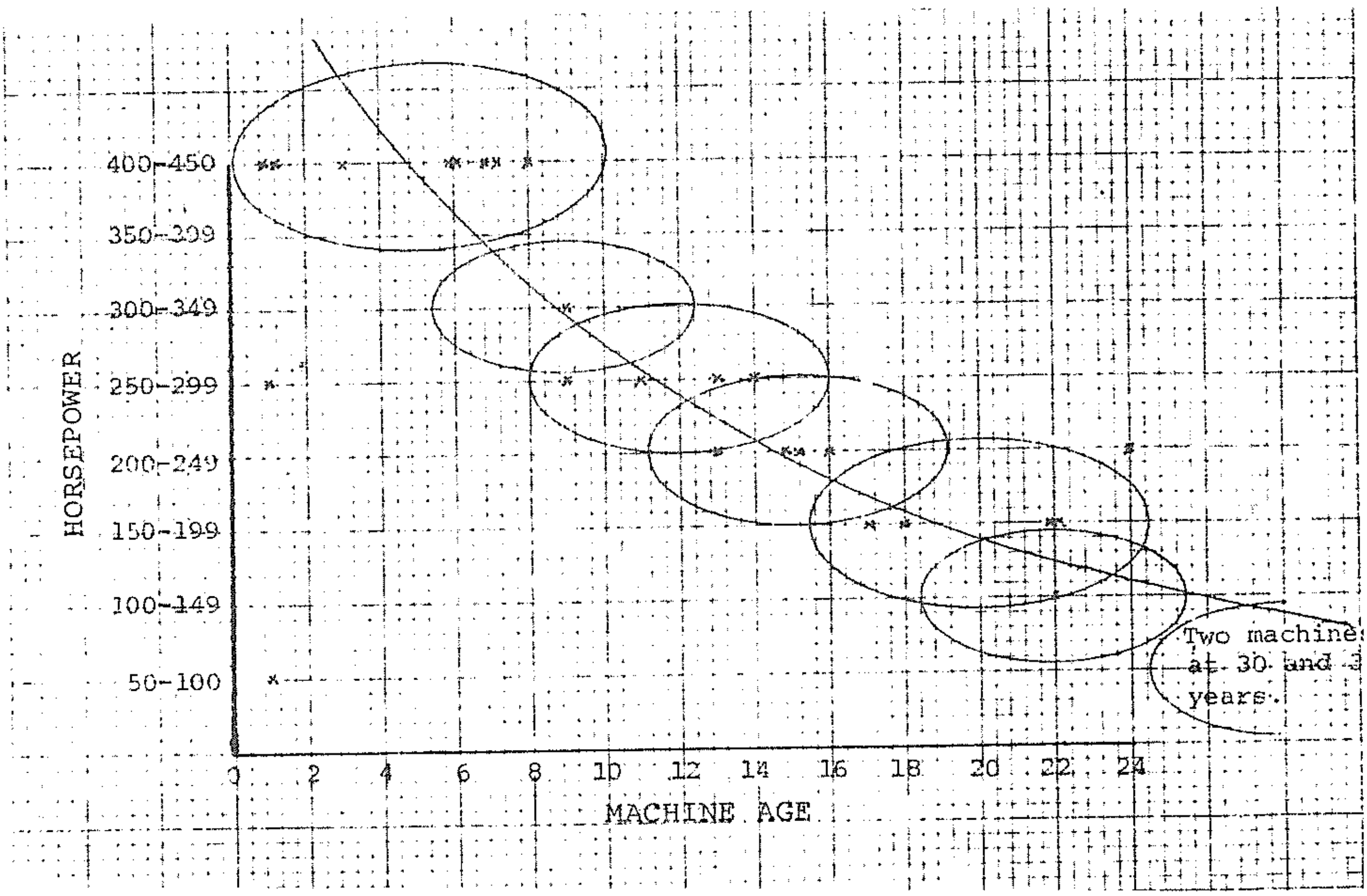
MACHINE MAKES - EXOTIC: The machine makes covered in the survey and their rated power are listed below:

NA = Not Available.

MACHINE MAKE	TOTAL NUMBER SURVEYED	ENGINE HORSEPOWER RATING
Madill	9	7 @ 450, 285, 220
Dispatch	4	420, 290, 150, NA
Westminster	5	320, 280, 2 @ 275, 180
Washington	2	300, NA
Skagit	5*	2 @ 220, 2 @ 165, 96
Hayes	2	200, 95
Wilson	5	175, 2 @ 150, 110, NA
Timbermaster	1	60 (Thinning)
Berger	1	NA
Price	1	NA

* *The higher hp machines were mobile Skagit Models SJ7 and SJ4 respectively whilst the 96 hp model was a stationary winch unit.*

MACHINE POWER/AGE RELATIONSHIP - EXOTIC: A comparison of machine ages with power ratings illustrates the growing trend towards greater power. This is probably as a means of achieving high productivity and the large tree sizes of the old crop Radiata stands currently being harvested. One exception is the Timbermaster which is being used for thinnings.



MACHINE MAKES - INDIGENOUS: The makes of machines operating on indigenous operations and their power ratings are listed below:

NA = Not Available

MACHINE MAKE	TOTAL NUMBER SURVEYED	ENGINE HORSEPOWER RATING
Dispatch	10	250, 7 @ 185, 150, 90
Wilson	4	3 @ 154, 150
Skagit	2	96, 85
Allis Chalmers (Carco)	1	205
Unknown	2	NA

NOTE: In many cases the age of the machine being used on indigenous logging was not known by the current operator.

MACHINE MOBILITY - Undercarriage and Spar Type

The various options available between undercarriages and spars are tabled below.

Exotic Operations - The survey indicated that the bulk of the new machines were mounted on a self-propelled rubber-tyred undercarriage while many of the older units that have been modified were mounted on a rubber-tyred undercarriage for towing. More track mounted units were towed than were self-propelled and approximately a quarter of all exotic machines surveyed were sled-mounted.

UNDERCARRIAGES	%
Rubber - Self-propelled	26
- Towed	15
Track - Self-propelled	12
- Towed	21
Sled	26
(34 machines surveyed)	100

SPARS	%
Wooden - Eucalypt	41
- Rimu	12
Steel - Tubular	28
- Lattice	19
(32 machines surveyed)	100

Indigenous Operations:

UNDERCARRIAGES	%
Rubber - Self-propelled	18
- Towed	9
Track - Self-propelled	9
- Towed	-
Sled	64
(11 machines surveyed)	100

SPARS	%
Wooden - Eucalypt	-
- Rimu	73
Steel - Tubular	-
- Lattice	27
(11 machines surveyed)	100

The increase in the number of lattice construction steel spars for use on indigenous log haulers has occurred recently where machines have been modified for use under the constraints imposed by the new indigenous forest policy. More frequent shifts and setting up are required as there is less volume per unit area now available with partial or selective logging and highlead systems operate over shorter distances than was the case with skyline systems.

The poor availability of suitable logs for rigging as spars has also prompted a move to locally constructed steel spars for exotic operations in some localities.

ROPES:

Exotic Operations: The range of rope sizes as indicated in the survey is tabled below:

OPERATION	SKYLINE		MAIN ROPE		TAIL ROPE	
	Diam. mm	%	Diam. mm	%	Diam. mm	%
Clearfell	32	31	32	9	26	17
	28	31	28	9	22	3
	26	23	26	29	19	21
	22	7.5	22	29	16	26
			19	18	14	6
			16	3	13	21
Thinning	16	7.5		3	9	6
		100		100		100

Indigenous Operations:

Skylines: Of the two skyline operations surveyed both were using 32 mm rope.
Main Ropes: 26 mm and 22 mm only were used.
Tail Ropes: Majority operated with 16 mm ropes.

No data was collected on rope construction.

COMMUNICATIONS SYSTEMS:

Exotic Operations: 50% of the operations surveyed used the Talkie Tooter system and a further 25% operated with an Electro-bug system. Most of the remainder used two-way portable radios with a small number of ground-line electric horns also being used.

Indigenous Operations: 64% of machines surveyed used two-way portable radios while 27% used ground-line electric horns. Only one indigenous operation operated an Electro-bug.

CONCLUSIONS

It is evident from the data collected that there is a wide variation between machine types and auxiliary equipment for carrying out similar operations.

There is an increasing tendency towards modifying older haulers for use in indigenous operations where more frequent shifts are now necessary and because of a loss of skills in setting up and rigging spars.

Many ex indigenous haulers are being used on exotic operations where high production is limited by quotas, and where the size of the operation cannot justify high capital investment.

It is evident from the survey that quotas, low production requirements, loss or lack of development of traditional cable logging skills, the low value of wood, and in the case of native forests the new indigenous forest policy, all contribute to low productivity and generally high costs in hauler operations. This is particularly so in operations of low tree volume stands and native forests.

The survey indicates that an improved technology is desirable. The LIRA cable logging project is working towards this objective.

* * * * * *

SESSION II
PAPER III
APPENDIX (ii)

PRESENT STATE OF KNOWLEDGE

1. Bibliography of some of the relevant information currently held in LIRA's library.

CANADA

FERIC Evaluation of Cable Logging System in Interior B.C., and Alberta. Technical Report No. TR8, September, 1977, by Cottell, McMorland and Wellburn.

Alternative Methods for Logging Steep Slopes in the Nelson District of British Columbia, 1975. By Wellburn, Canadian Forest Service. (Book).

Skyline Logging Symposium, 1976, sponsored by B.C. Foresters, PNW FRES Forest Engineering Laboratory, FERIC and UBC.

Test of the Mini Alp Cable Yarder, Macmillan, Bloedel Limited, Forestry Division, Nanaimo, B.C., Canada, by Oswald, 1974.

UNITED STATES OF AMERICA

Cable Logging Systems by Studier and Binkley, Division of Timber Management, Forest Service, U.S. Department of Agriculture, Portland, Oregon, 1974. (Book)

Logging Practices - Principles of Timber Harvesting Systems by Steve Conway. (Book)

Sklyline Logging Symposium Proceedings, 1969. School of Forestry, Oregon State University. Edited by O'Leary. (Book)

Williamette Logging Specialists' Reference by Keith L. McGonagill, 1975. (Book)

High-lead Logging Costs as Related to Log Size and Other Variables, by Adams, 1965.

Analysis of Running Skyline with Drag, by Carson P.N.W. 193, 1975.

A Comparison of Highlead Yarding, Production Rates and Windthrow and Standing Timber by Binkley, P.N.W.13, 1964.

Running Skylines Reduce Access Road Needs, Minimise Harvest Site Impact, by Burke, reprint from Forest Industries, May, 1975.

Grapple Yarding Revolutionises Logging, by Lysons, reprint from Western Conservation Journal.

Skyline Logging Symposium Proceedings. University of Washington, 1974. Edited by Jorgensen.

Skyline Logging, an Economical Impact of Logging, by Lysons and Turito. Reprint from Journal of Forestry.

Understanding Interlock Yarders, P.N.W. 221, by Carson and Jorgensen.

Problems in Mechanising Commercial Thinnings, by Adamovich, 1968.

Harvesting Commercial Thinnings on Steep Slopes, by Lysons. Reprint from Global Forestry and the Western Role, 1975.

A new Concept for Thinning on Steep Ground, by O'Leary. Reprint from Symposium of Managing Young Forests in the Douglas Fir Region, 1972.

Skyline Effective for Thinning Douglas Fir on Steep Slopes, by Binkley and Williamson. Reprint from Forest Industries, February, 1968.

EUROPE

The Place of Short Distance Cable Cranes in British Forestry, by Drummons, Rowan and Troup, (a paper to the symposium of forest operations in mountainous regions). U.S.S.R., 1971.

Cable Logging in Norway, by Lisland, 1975.

Endless Cable Makes Thinning Profitable, World Wood, August, 1976.

AUSTRALIA

Skyline Extraction of Hoop Pine Thinnings, by Cumberland, Forestry and Timber Bureau, Department of Primary Industry, 1974.

Extraction of Pinus Radiata by Cable System, by L. Henderson, C.S.I.R.O., H.R.G. Report No. 2, 1976.

2. Reports and Papers by FRI Harvesting Research Group.

A. General

"Survey of the logging industry for the year ended 31 March, 1974"
Economics of Silviculture Report No. 84 (1976)
T. Fraser, G. Murphy, C.J. Terlesk.

"Cable Logging in the exotic and indigenous forests of New Zealand".
Economics of Silviculture Report No. 89 (1976)
G. Murphy.

"Element descriptions for cable logging operations."
Economics of Silviculture Report No. 98. (1977)
G. Murphy.

"FRI survey of the logging industry 3: Cable logging."
Forest Industries Review 8 (1): 30-34 (1976)
T. Fraser, G. Murphy, C.J. Terlesk.

B. Production Thinning

"Strip thinning in young Pinus radiata: an operational and crop assessment."
Economics of Silviculture Report No. 68 (1973)
R.N. O'Reilly, J.D. MackIntosh

"Strip extraction thinning by a Timbermaster skyline: uphill setting."
Economics of Silviculture Report No. 107 (1977)
A.A. Twaddle

C. Clearfelling

"Costs of logging radiata pine at Kaingaroa Forest: a cost study of tractor and hauler extraction by the Waipa clear-felling gangs in 1968"
Economics of Silviculture Report No. 21 (1969)
M.B. Grainger.

"Factors effecting the production and productivity of cable-logging crews. 1. Skyline Logging."
Economics of Silviculture Internal Report No. 16 (1973)
R.N. O'Reilly.

"Log length extraction by a Timbermaster skyline."
Economics of Silviculture Report No. 90 (1976)
G. Murphy

"Cable Logging in mature Radiata pine: A case study of a mobile Madill operation."
Economics of Silviculture Report No. 103 (1977)
G. Murphy

"A Pilot Study of three log preparation alternatives for cable logging."
Economics of Silviculture Report No. 104 (1977)
G. Murphy

"Factors affecting the output of a Skyline logging gang."
Forest Industries Review Dec. 1974
R. O'Reilly

"Uphill or Downhill Cable logging?"
Forest Industries Review. 8 (10) 34-36 (1977)
G. Murphy

"Factors affecting production and productivity of a mobile Madill gang."
Forest Industries Review (1978)
G. Murphy

"Three systems of log preparation for Cable logging."
Forest Industries Review (1978)
G. Murphy

3. Reports by NZFS Experimental Logging Unit, Golden Downs Forest, 1966-1968. These are mostly Internal Reports held on files at Golden Downs Forest or NZFS Head Office, Wellington.

4. Standard setting studies:

   (a) NZFS studies of haulers at Maramarua, Tapanui, West Coast Beech Project, Kaingaroa.

   (b) Kaingaroa Logging Company (all machine types).

   (c) NZFP (all machine types).

5. Method Studies:

   (a) NZFS - Guy construction
   - Wilson hauler, Port Craig
   - West Coast Beech Project (three studies completed)

   (b) NZFP - Hauler tail blocks
   - Grapple haulers

   (c) KLC - Skagit hauling
   - Madill spar
   - Documentation of activity for training

6. Machinery Evaluations:

   (a) LIRA - Timbermaster
   - Madill 071

SESSION II
PAPER IV

NORTH AMERICAN AND EUROPEAN RESEARCH ON CABLE HAULING PROBLEMS

J.J.K. SPIERS
Director, LIRA

Over the past few years, wide-ranging investigations into cable hauling has been carried out in the North Hemisphere because:

1. Most of the hitherto unexploited timber resources are on steep ground.
2. There is a need to efficiently harvest thinnings or partial cuts on steep ground.
3. Environmental constraints are limiting road and skidding systems which cause ground disturbance.
4. Roading costs are rising more rapidly than hauling costs, thus haulers may enable reduced road density.

This paper examines briefly the main lines of research under two broad headings:

The studies primarily concerned with productivity, costs, and environmental impact.

The development of methods and machinery.

Most of the North American work relevant to New Zealand originates from the Pacific North West region and is well documented in various research reports. Although there is extensive work in both central Europe and Japan, this is less well known because of lack of reportage in English.

The review is by no means complete but some of the studies the author considers have relevance to operations, research and development in New Zealand are referred to. A bibliography of some other key references is appended.

OPERATIONAL EFFICIENCY, PRODUCTIVITY AND COSTING:

Under this heading two very important series of studies stand out. The Forest Engineering Research Institute of Canada's (FERIC) "Evaluation of Cable Logging Systems in Interior B.C. and Alberta "[1] and the series of co-operative studies carried out by the Pacific North West Forest and Range Experiment Station and Oregon State University, known as the Pansy Basin Studies.[2,3]

Prior to these two studies, G.V. Wellburn had examined and reported on "Alternative Methods for Logging Steep Slopes in the Nelson Forest District of British Columbia ".[4] This study was initiated in 1973, following the B.C. Forest Service's decision to restrict tractor use between 50-70% slope and prohibit tractor use over 70%, and 95% of it had been logged by tractor. This ruling triggered investigation and research to develop ways and means of economically logging such terrain. Following an examination of existing and available systems, and the results of preliminary investigations and case studies, the report identified the importance of planning, particularly the relationship of road network to extraction methods in achieving optimum physical, economic and environmental results. The findings were that:

1. The difficulty and expense of logging by any method increased as slope increased.

2. Tractor logging was the most economic system and most adaptable for many areas. Much damage to soil values could be reduced by good planning and supervision.

3. That the biggest impediment to the introduction of cable logging to a new area was lack of trained personnel at all levels in the enterprise.

4. That given 3, short distance cable hauling systems such as jammers and smaller mobile spars working in conjunction with tractors would initially give the best opportunity for economically acceptable results, provided long term integrated planning was adopted.

5. Stumpage values would need to be adjusted to compensate for the higher costs incurred.

FERIC'S COMPARATIVE EVALUATION OF CABLE SYSTEMS:

This report[1], summarised in LIRA's Digest Vol. 1 No. 1 1977, studied eight cable logging operations over a two-year period to obtain information on machine characteristics and limitations, crew requirements, operations methods, productive and delay times, and output. The study, comparing performance over 581 shifts, identified the following key features:

Mechanical availability of the yarding machines was generally high. 90% or greater could be anticipated if sufficient maintenance support was available and the crew experienced.

Machine utilisation varied widely ranging from 42-87%. The effectiveness was strongly influenced by crew experience and efficiency in planning and management.

Average haul cycle times varied widely from 2.5 to 12.5 minutes per turn operating cycle time took generally 50% to 60% of total time.

Breakout time was the largest time element in the hauling cycle (roughly 25%). Main rope changes took 10-15% of operational time.

Productivity of the systems studied indicated that it was very difficult to exceed more than 200 logs per shift. Therefore piece size was a key factor in production volume and cost.

The FERIC report concluded that the major technical problems to be solved were:

1. Better integration of hauling, loading and processing of logs on steep hillside landings.

2. Design of an inexpensive machine that could operate with a small crew to haul small logs efficiently on steep slopes.

3. Improved planning and management of cable systems.

THE PANSY BASIN STUDIES:

This series of studies compared production rates and costs between high lead, shotgun, north bend, running skyline, balloon and helicopter systems under various conditions of timber and terrain and a range of management prescriptions. The studies aimed at:

1. A comparative analysis of production rates and costs.
2. Identification and measurement of critical parameters upon which yarding efficiency is dependent.
3. Identifying ways of improving the existing systems through better use of men and machines.

The first series in 1973 (in clearfelling only) indicated productive yarding time to be a function of distance, turn volume, number of logs per turn, and conditions in the hook-on site, in all systems. Additionally, for the aerial systems, slope and tag-line length affected production time. Unproductive time, (delays and down-time) are important segments of total time for all systems and were unpredictable for the most part. The study analysed non-productive elements and isolated possibilities for further improvement, particularly in such things as skyline road changing. Some of the more important figures from the studies were:

SYSTEM	MACHINE	H.P.	SPAR Hgt. (Ft)	% DELAY	% ROAD CHANGE	% OUT-HAUL	% BREAK-OUT	DROP
High Lead	West Coast Falcon	239	49	15.5	3.4	13	39	26
North Bend	West Coast Falcon	239	49	15.5	2.1	11	50	26
Scab Skyline	Smith-Berger Planet-Lok	300	50	6.6	4.4	15	46	17
Shotgun	Skagit BU90/ T.90	510	90	9.2	10.0	13	51	11
Balloon	Washington	725	-	15.5	4.9	18	39	20
Helicopter	Boeing Vertol	1250 x 2	-	28.2	-	41	22	0

The second phase of the studies in 1974 compared production rates and costs for running skylines, balloons, and helicopters. In partial logging as well as clear felling with the following results:

System	Machine	H.P.	Vol. per turn m^3	Cost per m^3	Fuel gal.per hr.
Running Skyline	Skagit GT3	200	3.75	2.68	8.2
Balloon	Washington Aeroyarder	700	5.12	5.90	27.5
Helicopter	Sikorsky Skycrane	400 x 2	7.57	9.30	525.0

The balloon could not be controlled effectively in partial logging and this silvicultural system effected skylines more heavily than helicopter. Other factors affecting the productivity in these studies were the lateral yarding distance and the number of men in the breaking out crew.

In further analysing the data from these studies, Dykstra noted that non-productive yarding delays added significantly to time and cost. The average delay for all systems was 28% of time but with increased complexity of the system the frequency of delays increased from high lead at about 15% to 20%, to helicopter at 27% to 42%. However delay percentage was not constant within each system, e.g. skylines varied from 7% to 24%. The cost of these delays (based on direct labour and equipment cost only) varied, but depended primarily on complexity of and investment in the system, e.g.:

Scab - Skyline(Grabinski)	Clearfelling	10.8¢ per m^3
North Bend	Clearfelling	22.5¢ per m^3
Running Skyline	Partial Cut	74.0¢ per m^3
Helicopter	Partial Cut	118.9¢ per m^3

Close examination of the categories of non-productive time showed that operating delays were important. These were short delays that did not require the yarding crew to be diverted from their normal duties. Many of them were 'systems' problems, e.g. delays whilst waiting for the loader to clear logs from the operating landing. Other common delays included hangups, snagged chokers, and breakages caused by hooking on over-weight turns. Such operating delays were substantially higher for the more complex cable systems such as North Bend and Running Skyline, compared with the simpler Scab-Skyline or gravity systems, but high lead, due to its frequent hangups caused by less lift, had also a very high frequency of stoppages. An examination of the operating delays showed a corelation for the high lead and scab-skyline systems between delay time and distance yarded.

The repair delays were predominantly repairs to the hauler, except on the running skyline operation. Here the higher percentage of repair time on the system studied was attributed almost entirely to problems with its slack-pulling carriage. The findings suggested that expected repair time should be increased wherever silvicultural prescriptions require the use of complex cable equipment.

TOTAL COST COMPARISON:

A deficiency in FERIC's evaluation, and in the Pansy Basin study was that only the yarding systems were studied and the full implications of roading and other overheads that affect the total cost of logging in any particular area were disregarded. FERIC's report No. TR-19[6] recognised the deficiency of the earlier studies and compared the traditional high-lead operations of coastal British Columbia with a number of long-reach alternatives. This 1977 study compared the costs of five different system alternatives planned for a 3,650 acre. area on the British Columbia coast. The costs used were based on real cost data from represenative operations in the area for the skylines and balloons, and an estimated cost for a new concept, the aero-crane system. The analysis covered the following systems and equipment:

SYSTEM	*MACHINE*	*MACHINE CAPITAL COST* $	*SYSTEM HOURLY COST* $
Highlead	*Madill Model S*	*204,000*	*115.44*
Running Skyline (fixed spar)	*Madill 052*	*284,000*	*157.13*
Running Skyline (yarding crane)	*Washington 118*	*502,000*	*189.68*
Balloon	*Washington 608 + Raven 530K balloon*	*1,052,243*	*405.74*
Free Flying Vehicle	*16-ton Lift Aerocrane*	*1,316,600*	*659.78*

They calculated total costs of the system, including road access, based on planning to the maximum hauling distances of each system. They found that although high lead had the cheapest hauling costs, the total cost picture indicated that better overall costs were possible for all of the longer reach alternatives except balloon. The total costs for each of the systems over the whole acreage for a production volume of 438,000 units was calculated to be:

SYSTEM	ROAD ACCESS	FALLING $	YARDING $	LOADING $	HAULING $	TOTAL $	DIFFERENCE FROM HIGHLEAD
Highlead	2,365,200	2,058,600	4,042,740	1,817,700	2,790,060	13,074,300	0
Running Skyline - Fixed Spar	1,533,000	2,106,780	4,682,220	1,427,880	2,763,780	12,513,660	- 560,640
Running Skyline - Yardg.Crane	1,252,680	2,150,580	4,323,060	1,449,780	2,211,900	11,388,000	-1,686,300
Balloon	1,278,960	2,251,320	6,600,660	1,624,980	2,755,020	14,510,940	1,436,640
Aerocrane	661,380	2,277,600	5,838,540	893,520	2,391,480	12,062,520	-1,011,780

(TOTAL VOLUME - 438,000 CUNITS)

Hauling costs represented the highest cost component for each of the five systems, and the average hauling cost for the long-reach skyline systems were all greater than high lead. Loading costs reflected the system interaction between hauling and loading, whilst total road access costs decreased as yarding distance increased, and this proved significant in bringing the total cost for the long reach systems, (except balloons) below that of high lead.

The report emphasised that long reach systems are inherently more complex and require higher standards of planning, supervision and mechanical servicing to maintain production level. In interpreting the results for New Zealand conditions, it needs to be recognised that road costs are nowhere near as high as those of British Columbia, and thus in most cases the simpler systems would possibly have advantages if a similar exercise was done in this country.

INVESTIGATIONS IN THINNING:

Silvicultural thinnings have always contributed markedly to the complexity of the logging system and costs have invariably been higher than clearfelling. Two recent approaches to improving thinning methods are probably worthy of note.

In Bavaria, Munich University and Forest Research Institute have carried out investigations into the use of two classes of a Urus Mobile hauler in thinnings of stems ranging from one to four cubic metres[7]. These studies based on 19 operations examined techniques, production, costs and degree of damage to residual stems, and compared the breaking-out of logs with the primary hauler to the use of a radio operated radiotir winch. These investigations pinpointed the following results:

1. The major variables effecting production were: mean average DBH of extracted stems; mean average hauling distance; type of pre-hauling; distance of pre-hauling or breaking out to the main line; degree of processing; and crew skill.

2. Thinnings of higher intensity at longer intervals between thinnings gave possibilities for markedly reduced cost.

3. With different set-ups close together with more or less parallel hauling direction, the amount of time changing lines, setting up, and moving, could be reduced markedly.

4. Downhill hauling, although possible, required special devices to avoid damage.

5. A regime that combined selective thinning with strip cutting gave higher production and less residual damage.

6. The use of the Radiotir for pre-hauling improved cost of the operation and indicated possibilities for future rationalisation.

The study concluded that mobile cable cranes offered an opportunity to undertake thinnings under difficult conditions at reasonable costs.
(NOTE: High wood values in Europe allow much higher operating costs than is possible in New Zealand).

DEVELOPMENT OF METHODS AND MACHINERY:

Cable hauling systems and machinery will be dealt with in more detail in the following session, but some comment on developmental concepts that have been the basis of overseas investigations is relevant here.

Conventional highlead and skyline systems using a large hauler are at a generally mature stage of development and although the machines that form the power house for these systems are being constantly improved and refined, primarily by the manufacturers, no attempt is made here to trace these developments. Rather the principle will be to identify some of the new concepts that could have an application to our future technological development. One could consider that there might be two main goals for such development:

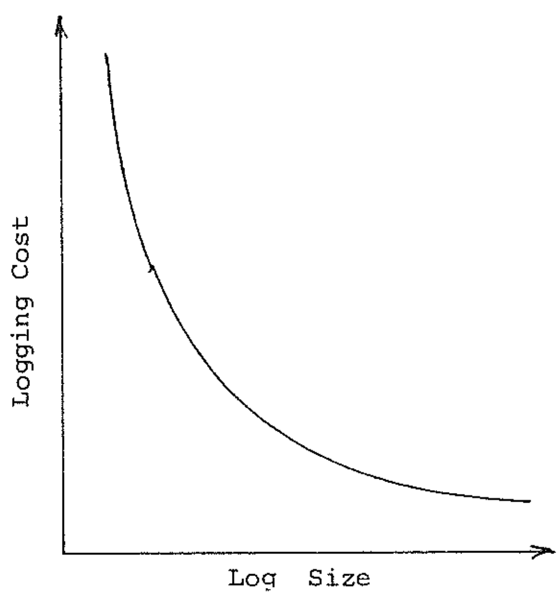
1. Can we use lighter, less powerful, cheaper, haulers?

2. Can we develop the felxibility to cope with all terrain conditions and partial logging problems?

RUNNING SKYLINE SYSTEMS:

Probably the most important development is the running skyline system concept in combination with an interlock hauler. The possibilities for flexibility of application of this combination are extremely important and the principles of operation have been covered separately in a background paper for this seminar (*see paper entitled "Running Skylines and Interlock Haulers" by J.J.K. Spiers)*. Interlock is not new, nor is the running (scab) skyline, but recent developments and the increased potential due to the use of hydraulic systems indicate considerable potential for improved cable logging.

The Pacific North West Forest and Range Experiment Station identified an accute need to harvest small commercial thinning on steep slopes to meet management plans for intensive forestry in an environmentally accepted manner. Hilton Lysons[8] showed that the technology existed but the problem was to apply it in an economically acceptable manner. This problem being that logging costs tend to rise exponentially as log size decreased:



LOGGING COST vs LOG SIZE

Lysons postulated that with small logs, logging costs were highly sensitive to production rates, thus any small decrease in production tended to give a sharp increase in logging costs. He reasoned that technical requirements for harvesting partial cuts on steep unstable slopes meant cable systems with a lateral yarding ability and an ability to hold a carriage in one position on the skyline. Such a system should be able to work all slope directions and thus requires a haul-back system rather than a gravity system. To minimise machine cost and set-up cost, the least number of operating cables to meet the requirements for inhaul, outhaul, partial load suspension, and slack-pulling was required. This could best be accomplished by a three-line running skyline. To operate the system, a highly mobile unit that could move frequently and thus reduce lateral pull requirements would be necessary. This implied a rubber-tyred self- propelled vehicle. His examination of the studies by FERIC[1], Aulerich[8] and Shaw[8] indicated that not many achieved rates of more than 200 pieces a day with conventional high lead or skyline systems, or by small multiple stand skylines. However, on the other hand, production from larger size three-line running skyline machines in clearfelling showed production capabilities of 500-700 logs per day. Thus research was focused on developing a machine that would reduce the size and cost of a high performance running skyline so that it could be applied to partial logging of small piece size timber. The result of this research is the development of the Pee Wee Yarder with a target price range of US$100,000 (1977). This fully interlocking three drum running skyline system is based on 110 H.P. JD640 skidder with an 11.3m tower mounted on it. The unit is currently undergoing trials and shows reasonable promise of success in yarding distances to 360m. with a lateral pull 45m. each side of the main cable.

ENDLESS LINE SYSTEMS:

It is notable that research engineers working in different parts of the world have come up with similar answers to the problem of developing cable logging equipment that is inexpensive, light, and flexible enough to operate in all types of terrain and for extended distances in mountain country. The design principles are based on:

1. reducing the winch weight, power requirements, and cost, by eliminating the necessity to store, carry, or constantly revolve large lengths of cable.

2. to synchronise the inhaul and outhaul functions by using a single rope powered by a capstan or grooved traction drum,

3. to employ carriages capable of being operated remotely by either cable or radio, to pay out and pull in a hoist or drop-line which can be taken to the logs. Tensioning the system is usually done by pulling a bight in the operating lines.

The Norwegians[9] have developed a radio control system based on a hydraulically driven grooved traction drum winch and an automatic carriage that is moved on a fixed skyline by an endless rope. The carriage has a capstan operated drop-line which is activated when the carriage meets an adjustable stop on the skyline. With a closed hydraulic system used, it is not necessary to use clutches or brakes on the winch and the system can easily be controlled remotely by radio from both the landing and the bush end. Extra storage drums are provided on the machine for storing the skyline, endless line and straw line during shift.

In Japan, the forestry agency, the leading Universities, and industry companies, combined resources to develop machines for their mountain logging conditions - poor road access, small land ownerships, low production requirements, and very rugged terrain. They identified a basic need for light inexpensive haulers with great range and ability to deal with all conditions. As a result, they designed endless yarders based on standard small diesel or gasoline engines which incorporated a capstan drum which could be operated at high speed and imposed no limit to the reach of the system. In the simplest machines designed, a normal drum held a lifting rope which was used to break out the log and lift to the carriage with a Tyler type cable system. From the basic system more drums were incorporated in the bigger machines and a wider variety of operating systems to cope with almost any terrain were subsequently developed.[10]

In the USA, Purdue University[11] developed an aerial cable system to meet the environmental requirements of the Appalachian area which demanded lifting logs clear off the ground in areas where a restricted allowable cut and timber size did not make employment of the normal West Coast systems and equipment economically feasible. Their development was based on using the running skyline principle on a machine incorporating tandem capstan drums rather than normal drums. One normal drum being rigged to control raising and lowering of the carriage by pulling a bight in the endless line. This system is operated by a hauler, powered by a torque converter-equipped Ford industrial engine and gives speeds of 560 feet per minute for a 3000 lb. pull. Preliminary trials indicate that fact cycle times and the cheaper equipment used give the system potential in selected areas where logging by tractor methods is not permissible.

It should be noted that the endless cable systems have been developed to overcome restricutions in their particular countries. Usually the non-productive set-up time is much longer than with other systems, thus they may have limited application in New Zealand in their present form as roading networks here are normally adequate. However, they do prove that cheap, lower powered, lighter weight machinery can be used with a system that has the flexibility to cope with long distance yarding and all types of terrain. These systems are labour intensive, low energy, steep slope, long distance systems, that cause little ground disturbance or residual tree damage. Daily production is relatively low but so are equipment operating costs. These characteristics restrict physical and economical application to where more productive systems cannot be used for environmental reasons for will not work because of the ruggedness of the terrain.

INTERMEDIATE SUPPORT SYSTEMS:

Skyline systems using intermediate supports are widely used in Europe and Japan as gravity downhill logging systems. Such systems are dependent on high rigging of hangers and cross cutting of logs in the bush to shorter lengths to enable the turn to run clear of the ground on its passage down the skyline. Although such systems have been tried in North America and New Zealand, they have not been notably successful because of rigging difficulties and high cost of operation.

More recently, in both US and Canada, as well as in Austria, intermediate support systems have been developed for full tree length logging uphill. Trials have shown that low powered prime movers can be used to log extended distances in partial logging operations over uneven and complex terrain which would prove difficult for the normal cable systems.

Both Oregon State University[12] and McMillan and Floedel Co. have experimented with the Norwegian designed Mini-Alp trailer-mounted yarder powered by a farm tractor in thinnings of Douglas Fir. The system used is able to exploit the improved lift capabilities of a skyline over the whole of its length on convex terrain because of the use of hangers. With such a system it is possible to break-out logs to the skyline and log reasonably sized turns with a small horsepower prime mover. The rigging time is greatly reduced in this application because the logs remain partially on the ground and the hangers are rigged only at about 25 ft. Open sided carriages such as the Koller are used to pass the hangers. This system can be used with a wide range of smaller haulers; the main essential being a carriage with slack throwing capacity and an ability to pass over hangers.

Development is currently continuing at Oregon State University to estimate productivity, cost, and mechanical capabilities with a range of tree factors and terrain factors.

AUTOMATION:

No exploration on mechanised developments is probably complete without some discussion of automation concepts.

The potential of electronic control in the forest industry is being investigated by the Forest Engineering Research Station in Seattle, the University of Washington, and firms such as Forestal Automation. Their studies of digital logic control of interlock yarders, analysed operations of a typical skyline yarder and concluded that automatic control was feasible and desirable.

For example, the steps that an operator takes in tailroping the carriage of an interlock running skyline from the landing are as follows:

1. Engages the haulback, slack-pulling and main-drum clutches.
2. Sets transmission in tailrope position.
3. Releases main, slack-pulling and haulback drum brakes.
4. Accelerates engine to desired speed.
5. Controls haulback line speed, (and tension- deflection) by interlock control lever.

An analysis of the basic control elements for all the machine functions including the above, indicated that a simple computer three-bit memory output is capable of controlling all the complex operational functions of a skyline hauler in a fail-safe way to ensure that no controls could operate without the compatible adjacent controls being in the correct position or, alternatively, that a control could not be operated out of its normal operational sequence (e.g. tension would be maintained on a skyline system so that no error by the operator could result in dropping the carriage or that the clutch on one drum and the brake on the other were operated in harmony).

With such electronic controls, it has been possible to operate machines from both the landing during inhaul and unhooking, and from the bush during tailropping and choking. The advantages of developing such automated systems are seen to be:

No necessity for a full time machine operator.

No need to build a cab, operator's control and the associated plumbing.

Less experienced operators could be used with less fatigue.

Control of the machine from the position of work would mean no need for complicated communications.

SUMMARY:

I would conclude by saying that in New Zealand we are at an immature stage of our development of cable logging systems. There is a tremendous scope for application of science, initiative and ingenuity to improve our technology. I believe that it is even possible to beat skidding costs on comparable terrain. In any event, we should be asking ourselves these questions:

1. Is there a possibility of cable logging competing on favourable economic terms with other systems?

2. Given that cable logging is more expensive and difficult than other methods, under what circumstances should it be used?

3. What improvements in systems, machines, planning and management of cable logging are necessary to make it more efficient and economic?

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LIRA CABLE HAULING SEMINAR

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RUNNING SKYLINES AND INTERLOCK HAULERS

Two commonly used cable systems in New Zealand are high lead and skyline. The former has the advantage of simple rigging, and can be used with a wide range of two-drum haulers. The function of high lead is to raise the lead block, thus giving lift over obstacles. The lift effect may be limited by the height of the spar, the nature of the landing, the slope and the ground profile. In many cases with uphill hauls to large landings such as are used for processing the tree-length logs in New Zealand, no lift at all is possible.

Skyline systems using either fixed or live skylines are more difficult to rig and it takes longer to carry out line changes. For live skyline systems a more expensive three-drum hauler is required. Many of these systems can handle large loads over long distances but they are expensive and have limited mobility.

More recently to combine the advantages of both systems, running skyline (scab skyline) systems have been used, primarily with large high-powered steel tower haulers for both choker and grapple operations. The running skyline basically combines the function of haul back and skyline in one rope and is able to impart much more lift to the load. The system has the ability to reach longer distances over a wider range of terrain than high lead and is easier to rig and operate and has improved mobility over traditional skyline systems. With appropriately designed three-drum haulers, grapple operation and slack pulling ability for partial logging or thinning is possible.

The prime need for an effective running skyline system is very good control of the tailrope, or an interlock mechanism, to enable the system to function effectively without dissipating power.

The Mechanics of the Running Skyline Need to be Understood

Basically, the running skyline gains its lift and is able to control its deflection by tensioning the tailrope line. To overcome this tensioning pull, considerable mainline power is required to move the rigging and the load toward the landing unless a device for interlocking inhaul and outhaul drum movements or transferring power between them is incorporated in the machine. Some form of interlock is necessary for effective economical operation.

Let's examine the requirements step by step, (the friction losses and variations in ground resistance in the system will be disregarded in these examples).

In the simplest hauling situation, given a load resistance of 1 tonne and an inhaul speed of 120 metres per minute, the power required is approximately 27 h.p.

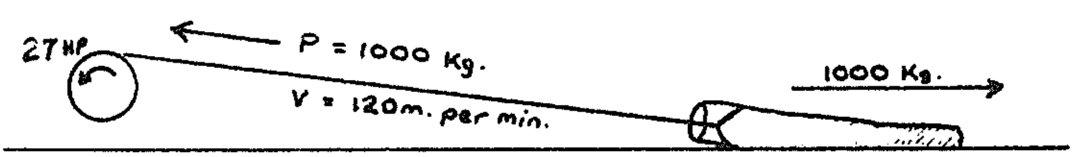

FIGURE 1

If we add a tailrope and assume no load from this the same situation applies. There is no load on the tail hold.

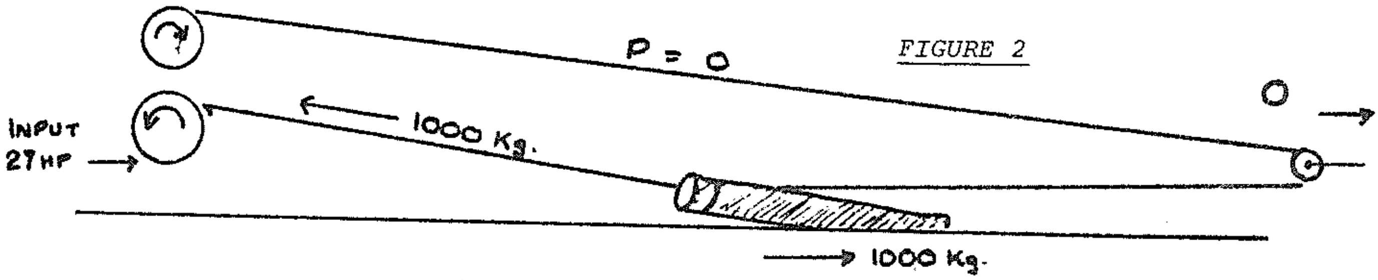

FIGURE 2

We now try to lift the load by tensioning the main and tailropes together, the power requirement increases dramatically as indicated. (The actual power required of course varies with deflection and the power required for braking on the tailrope is dissipated through heat. Note the greatly increased tailholdi[ng] load.)

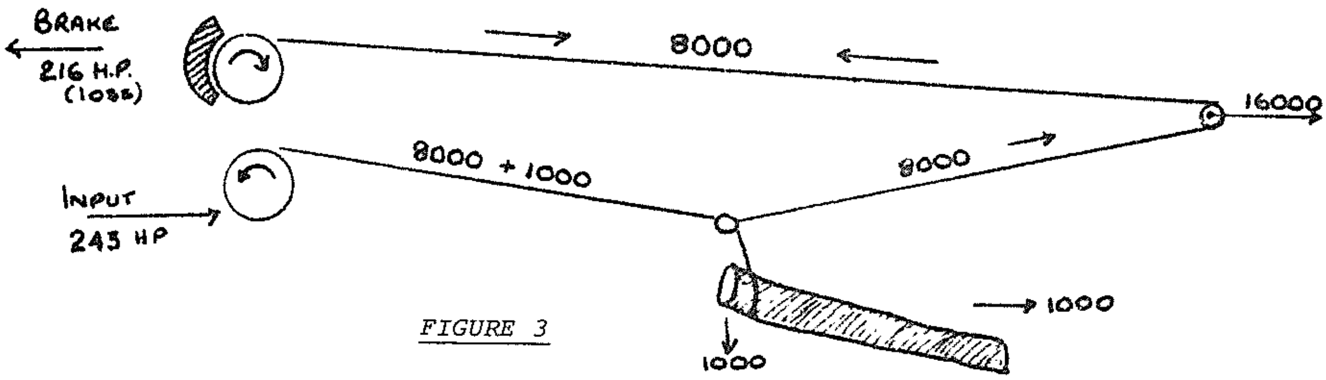

FIGURE 3

However if we rig as a running skyline two sets of rope are lifting, the power requirement is consequently reduced, and the pull on the tailhold is halved.

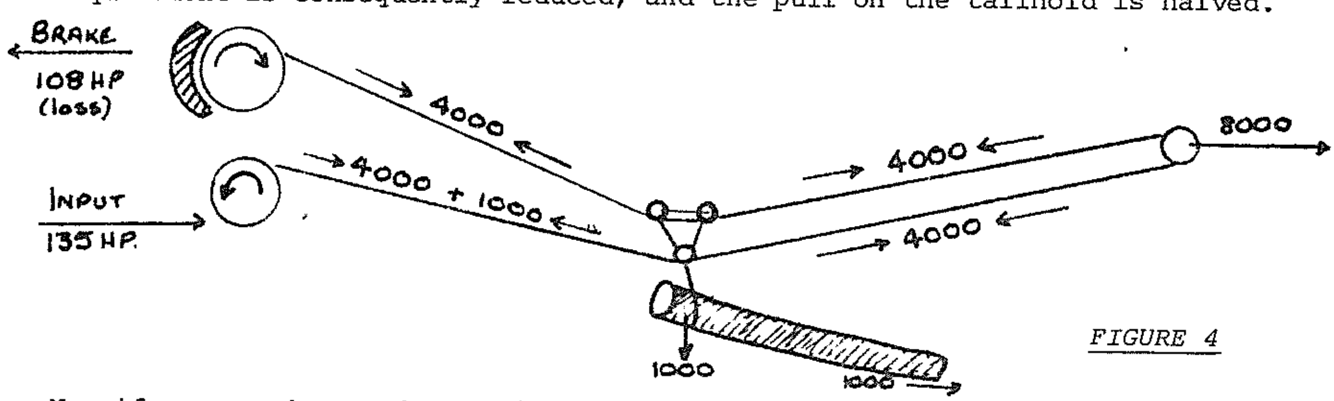

FIGURE 4

Now if we can change the machine design so that the system is interlock or power generated at the tailrope drum is fed into the powering of the main drum, we have the following situation. The power requirements reduce again to the basic requirement to move the load.

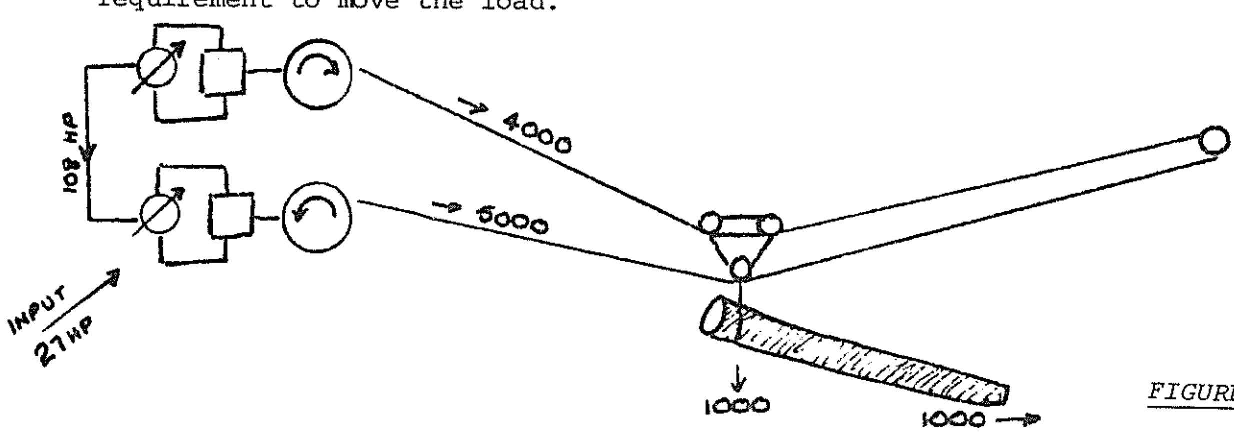

FIGURE 5

If we want to operate a grapple, or alternatively throw slack for yarding to the side as in thinning, addition of another drum is possible without increasing the power requirements to pull in the system.

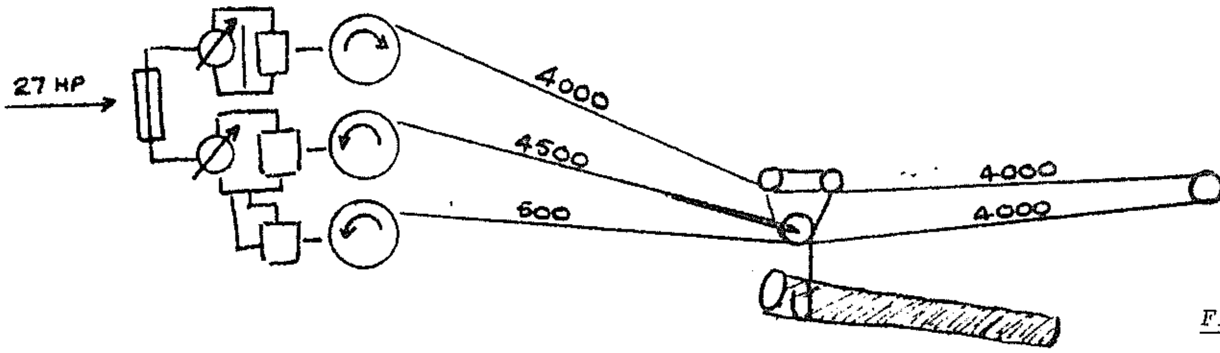

FIGURE 6

The Hauler

Obviously a desirable requirement for an effective machine to operate a running skyline system is an effective interlock mechanism that functions without dissipating power.

Probably the only interlock machine to have hauled logs in New Zealand was the Lidgerwood steam skidder operated by the Port Craig Sawmilling Company in Western Southland in the early 1920's. The interlock consisted of gearing between the main and haulback drums and had no compensation for changes in drum diameters. Thus it had to be adjusted at intervals during the hauling phase.

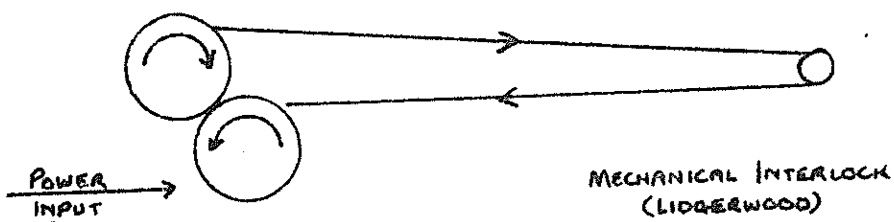

FIGURE 7

Current New Zealand machines operating running skylines are not designed for the system and thus rely on powerful, non-regenerative brakes to hold the rig up in the air. A very powerful machine is required to haul and the braking energy is lost as heat.

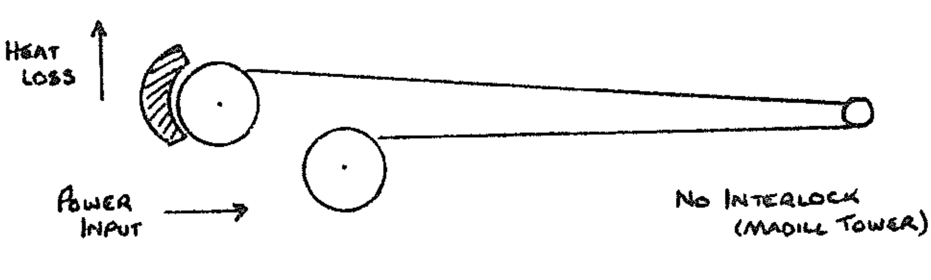

FIGURE 8

Regenerative brake interlocks employ a means of transferring power from the haul back drum to the main drum through a slipping clutch or brake. The slippag is necessary to compensate for changes in drum radii as the carriage moves in or out, or the rigging is raised or lowered. Such a system is usually designed so there is no slippage at the extremities of the haul and it gradually increases to a maximum as the haul approaches the landing. The power loss in this system, although much less than a non-regenerative system, is still significant.

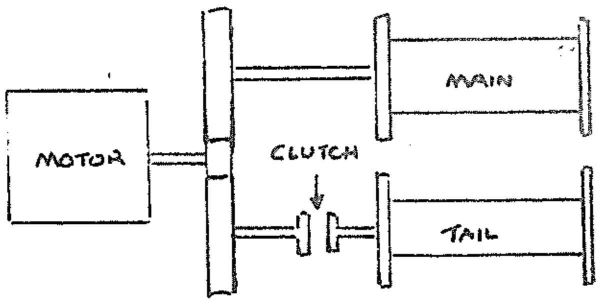

FIGURE 9

Hydraulically controlled interlock systems being either planetary gear and/or hydraulic motors with reversible variable displacement pumps overcome most of the foregoing problems and minimise the power losses in the system. If one assumes an overall efficiency of 75% in the hydrostatic transmission, the require input power for given load requirements is reduced to a minimum. Additionally, the system can be engineered to avoid overloading the system, (e.g. this helps avoid pulling out back stumps).

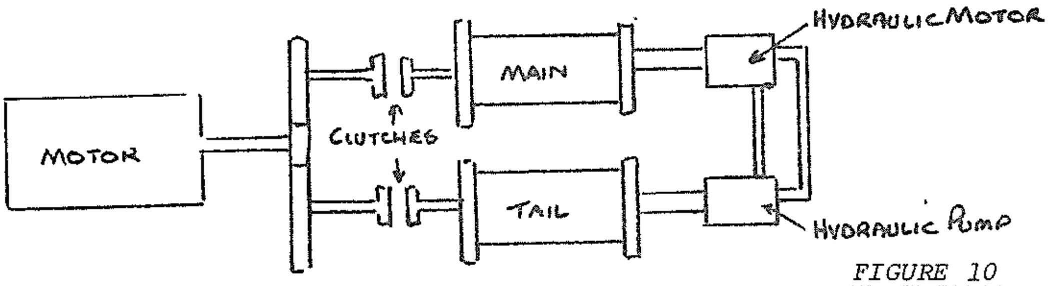

FIGURE 10

Such running skyline systems have proven to be efficient and economical in harvesting large and medium size logs in clear cutting in the Pacific North West of the USA. Such machines as the Washington 118 Skylok Yarder, can commonly produce 500-700 pieces per day, but their cost at $500,000 or more makes them economically impractical for small logs, partial cuts or low quota cutting requirements. The problem has thus been to scale down the machines in size and cost, and yet retain their flexibility, ease of operation, and long-reach capacity.

Development of Small Interlock Haulers

Three developing designs of small interlock haulers are worthy of note as similar machine concepts could have a singificant part to play in future New Zealand logging operations.

The engineering section of the Pacific North West Forest and Range Experiment Station in Seattle has designed and is carrying out trials with a three drum hydraulically operated interlock hauler based on a John Deere 640 skidder (110h.p.). It is designed for use with a running skyline system using a slack pulling carriage for thinning operations. Currently it has the ability to haul 365 metres with a side reach of 45 metres. An 11.5 metre tower mounted over the drum set gives adequate lift to the butt rigging and the controls are simple. A design objective was to produce the machine for US$100,000, (1977).

H.P.C. Co., of Augsburg, West Germany, working in collaboration with logging engineering personnel of Munich University, are currently constructing an interlock machine the KMH Seilkran based on standard hydraulic motors and other standard components in series production. The prototype under construction will be capable of hauling 300 metres with a five-ton pull. The system is designed to be used for thinnings with a 240 kilogram three-sheave carriage holding 50 metres of 11 millimetre dropline. It is designed to be mounted on the smaller skidder or agricultural tractor with an 85 h.p. capacity and is expected to cost about NZ$55,000.

The Franz-Mayer-Melnhoff Company of Frohnleiten, Austria has constructed a series of mobile truck mounted haulers that overcome the interlock problem by a different method. Both the mainline and tail rope are driven separately by pairs of grooved traction drums of the same diameter which can be interlocked as required. These traction drums feed or take off rope from main and haul-back storage drums that are operated in unison with them, a hydraulic tension system allows the necessary drum slippage to compensate for changes in real diameter.

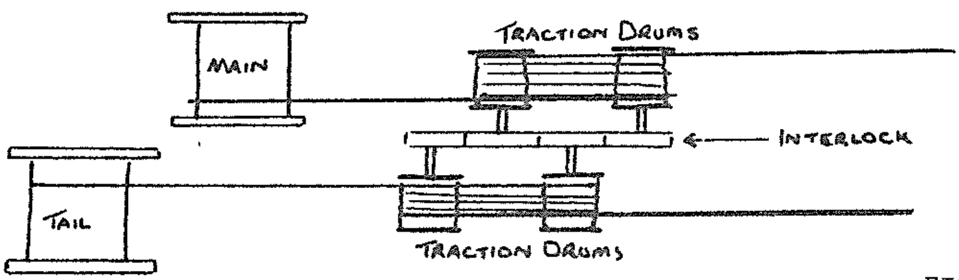

FIGURE 11

Summary:

High production in pieces per day, greater flexibility to deal with a wide variety of terrain, and lowered ownership costs are necessary if hauling of small trees or partial logging on steep terrain is to be economically successful. The running skyline system operated by a mobile, small interlocking hauler shows considerable promise in presenting a new technology to overcome these problems.

ACKNOWLEDGEMENTS:

I am indebted to Hilton Lysons and Chuck Mann of the Pacific North West Forest and Range Experiment Station: Walter Herz of H.P.C. Company: Lothar Kaierle of Munich University; and Kurt Vyplel of Frohnleiten, for most of the information presented in this paper. The following references were used:

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SESSION II
PAPER V

ESTIMATED CHANGES IN AREAS, VOLUMES AND CROPS THAT WILL BE HARVESTED BY CABLE LOGGING SYSTEMS

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Most of the basic data used to prepare this paper has been drawn from a wood supply scenario that has been written up for the soon-to-be published revision of the National Forestry Planning Model.

The Scenario has regard for the present condition of forests in New Zealand and attempts to project the consequences of forest management strategies that are implicit in current silvicultural regimes, management plans, or any other guide that exists to indicate the present intent of forestry concerns.

A few of the more important features and assumptions of the scenario need to be outlined. The historical pattern of establishment has a major impact. Graph 1 shows this pattern, revealing the two major planting booms; that of the late 1920's - early 1930's and that of the 1960's and 1970's. The current new planting rate, which totals some 45000 ha/year, is assumed to continue until suitable lands for afforestation in the regions run out. Allowing for complications caused by the imbalance in age class distribution of existing forest, and the need to at least maintain supply to existing industry, tree rotation lengths are assumed to gravitate towards about 30 years for radiata pine and 55 years for douglas fir.

Already about 75% of the wood volume logged per year is radiata pine, and by the year 2010 this ratio is expected to rise to about 95%.

The results of these and other assumptions give rise to projections of New Zealands expected roundwood removals which are summarised on table 1.

Table 1 Estimated New Zealand Roundwood Removals by all Logging methods (Annual Averages in Millions m^3)

Period:	1976:80	1981:85	1986:90	1991:95	1996:00	2001:05	2006:10	2011:15
Exotic:	8.8	9.0	9.2	12.5	17.5	24.3	33.3	36.1
Indigenous:	0.7	0.5	0.3	0.2	0.2	0.1	0.1	0.1
Total:	9.5	9.5	9.5	12.7	17.7	24.4	33.4	36.2

Graph 2 expresses this increase in availability of exotic roundwood pictorially. It also shows that the well endowed conservancies although losing somewhat in relative terms will continue nonetheless to be well endowed. Thirty years from now the total available roundwood will almost quadruple.

One can not be definite about the area of these burgeoning wood supplies that will be harvested by cable systems. However, providing technological development does not change the definition of forest land which would be cable logged the following guides can be used.

Murphy (1976) indicated that about 14% of exotic clearfelling in 1974 was by cable systems. By implication 14% of the restocking during the period 1971-75 will be cable country. Also the FRI land preparation symposium (1969) recorded that over the decade 1970:80 48% of the area that would be new planted would be non tractorable.

Table 2 Estimated New Zealand Average Changes in age, areas, volumes, and yields per hectare of exotic tree crops that will be harvested by cable and all logging systems.

	Total Exotic Roundwood Removals (all logging systems)					Exotic Roundwood Removals by Cable Logging	
	Average age of clear-felling (years)	Area to be clear-felled (000 ha per year)	Average recover-able yield (m^3/ha)	Recover-able yield (millions m^3 per year)	Percent cable logged	Area to be clear felled (000 ha/ year)	Recoverable yield (millions m^3/year)
80	48	12.2	746	9.1	18	2.2	1.6
85	45	12.0	733	8.8	21	2.5	1.8
90	40	12.8	710	9.1	25	3.2	2.3
95	31	19.6	653	12.8	29	5.7	3.7
00	29	28.6	622	17.8	33	9.4	5.9
05	29	38.4	635	24.4	36	13.8	8.8
10	30	51.4	650	33.4	40	20.6	13.4
15	31	54.2	658	35.7	44	23.8	15.7

Table 2 also provides insights about the likely changes in crops which will be harvested both by cable and other logging systems.

The relatively rapid drop in the age of clearfelling over the next 15 years will mean a concommitant drop in the mean piece size harvested, i.e. harvested trees will tend to become smaller in both height and dbh. A selected example which highlights the importance of investigating this phenomenon on a local basis is the Kaingaroa Forest radiata pine crop. It is expected to drop from a mean dbh of around 63 cm to 43 cm during the period 1986:90, a very important consideration if you are contemplating the purchase of new logging gear.

Volumes recovered per hectare are expected to drop from the current average of about 746 m^3/ha to a nadir of 622 m^3/ha during period 1996:2000 after which time they are expected to slowly climb again.

Such changes are largely a result of the 20 year planting gap between the mid 1930's and the mid 1950's, and the relatively late flourishing of the wood processing industry (1955 onwards).

In contrast to the relatively intensive management of post war planted stands, pre war planted stands were virtually untended. This will give rise to other crop changes which will affect cable loggers also.

Age for age the piece sizes of the post war planted crop will be greater than the pre war planted one because it has been (or else probably will be) thinned early and crop trees have had (or will have had) the opportunity to put on rapid diameter growth. The pre war planted crop was also thinned but it was thinned too late (by pathogens) to have a similar effect.

Because both the pre war and the post war planted crops were thinned the average number of crop trees for harvesting per hectare may not change much in future. If it does change, probably the change will be towards slightly fewer crop trees per hectare.

Genetically planting stock since the war has steadily improved thanks to tree breeding programmes. Generally this improvement has been accompanied by improvements in silivicultural treatment, and should mean that loggers have better form trees and more homogeneous crops to deal with in future.

Pre war plantings were seldom pruned but most post war plantings have been (or are intended to be)pruned. Overall about seventy percent of State Forests and forty percent of private forests of the appropriate age classes are currently being bottom log pruned. However, probably somewhat less is being pruned on cable logging country because steeper topography and more difficult access tend to make it second priority pruning country. Nevertheless significant increases in pruning will mean that loggers will tend to have less delimbing to do in future.

On the other hand the branches above the pruned butt logs of trees in heavily early thinned stands could be of significantly larger diameter than those above first log height on crops currently being harvested, and in future may be a little more difficult to delimb.

CONCLUSION

In conclusion, it is intended again to take up the point that we have a paucity of information about how much of the land considered suitable for afforestation is likely to be cable logging country.

Most of the data necessary to rectify this situation are available in the form of slope, soil and rainfall maps and a wealth of field experience. What is now needed is the allocation of a suitable officer to the task of drawing all this knowledge together with a view to preparing logging systems maps. Logging systems maps are urgently needed because without them it is not possible to make satisfactory estimates of the increases of finance, labour, and machinery that the logging industry will need. Without them we also run the risk of unnecessarily buying and afforesting cable country before tractorable country at a considerable cost to the nation. (The high cost of cable logging relative to other systems will no doubt be covered elsewhere in the seminar).

It is recommended that LIRA consider spearheading the preparation of logging systems maps.

REFERENCES

Chavasse C.G.R. 1969: Symposium No. 11 Land Preparation for Forestry in New Zealand. NZFS: pages 4-5.

Murphy G. 1976: Cable Logging in exotic and indigenous forests of New Zealand. Economics of Silviculture Report No. 89. NZFS: pages 2-6 (unpublished).

STRESSES AND STRAINS IN THE SYSTEM

J.L. WILSON,
Forest Consultant, Taupo.

TECHNICAL BACKGROUND (Stresses and Strains)

The basic commodity used in all logging operations is wire rope, but in cable logging it is even more important than in tractor logging. We use more of it, it is used in many different ways. In cable logging the characteristics of wire rope are critical to the operation.

This section of Session V will be used to set the background to the remainder of this and the subsequent session.

You have a hand out showing a glossary of cable hauling terms which include some relating to wire rope and systems, but there are others which are used. A glossary relating to wire rope and fittings is available in the LIRA library.

There are many documents relating to rope and systems and it is important that you be aware of them, what is in them and where they can be found.

Cookes' Wire Rope are the manufacturers and suppliers of more ropes into this and other industries in New Zealand. You should all be familiar with this book, (Steel Wire Ropes - Wire Rope Catalogue). In it you will find details on wire rope available for your use. It gives much useful information on rope types, their specification, and basic but important details on handling wire rope.

Key factors for this discussion:

Breaking Load

The actual load required to break a new rope under test. In practice the load could be higher but normally the rope will break at a weak point at a load less than the stated breaking load. Break because the rope is worn or has been abused.

Ropes have fibre and steel cores. A steel cored rope has greater resistance to crushing and a higher breaking load, but is stiff and harder to handle.

Rope Type

This details in numerical terms the construction of the rope. The most common type in this industry is 6 x 19. Another important type for easier handling is 6 x 31.

The 6 means the rope is constructed of 6 smaller ropes. The 19 or 31 refers to the number of wire stands in the smaller ropes. The less the number the stiffer the rope. Within this group of 6 smaller ropes there is a core of steel or hemp. A sub-definition such as 9/9/1 refers to the construction of the smaller ropes. The ropes we use are all round strand. There are, however, other types of rope for special uses; flattened strand, locked core etc.

Rope is expensive - down time is more expensive:

- Initial installation is important to the life of the rope, run it in to take out stretch and seat all the stands.
- Shock loading imposes a far higher impact load than the static load. While the properties of the wire will enable the rope to stretch and then regain its normal length again, shock loading always leads to premature failure.
- Lubrication. Rope may be dirty to handle but the lubricant is important to the life of the rope.

There are many other important facts on wire rope. Use the catalogues available, talk to the Cookes' representative in your area and obtain information from the LIRA library.

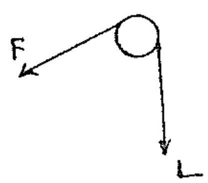
SAFE WORKING LOAD

The Safe Working Load is the Breaking Load divided by a factor of safety. The factor of safety will depend on the type of use and should normally vary between 3 and 6. A rope being used with a factor of safety of 6 will last approximately twice as long as one being used with a factor of 3.

Multiple Part Lines

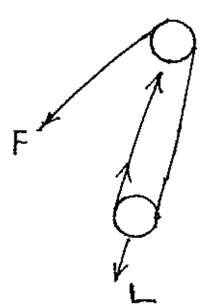
In a pulley system you will obtain a mechanical advantage depending on the number of parts of the line between the blocks or pulleys.

Put a rope over a block and the force used to pull the rope equals the load to be lifted.

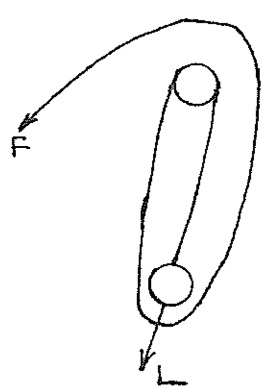


$F = L$

Put in a second block and run the rope back to the first block and you have a two purchase system and the force used equals half the load lifted and so on.



$F = \frac{L}{2}$



$F = \frac{L}{3}$

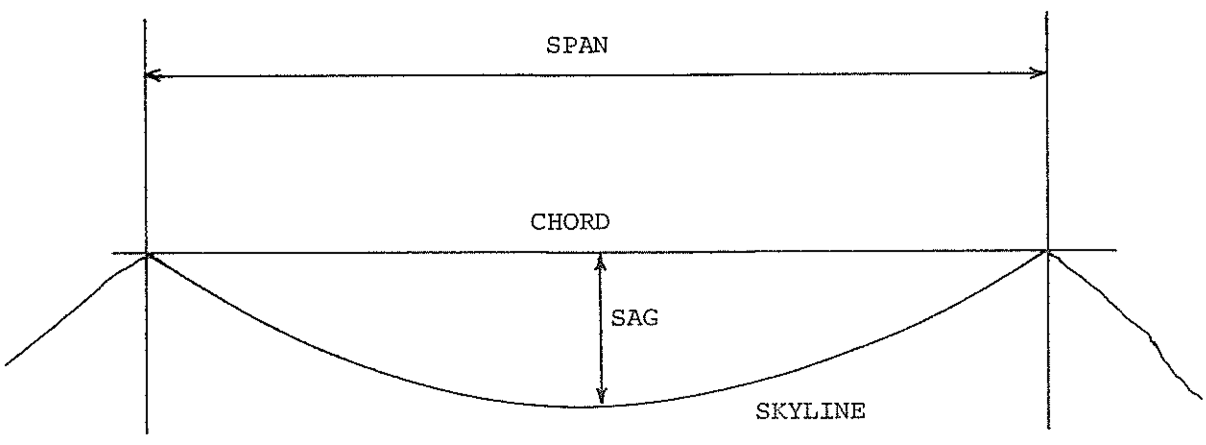
Unfortunately the more parts the less the efficiency. At a four part lift you lose approximately 10% of the mechanical advantage. With roller bearings the loss is 3-5% per sheave.

Whether lifting or pulling the same analysis applied. It is important to consider this when choosing the size of rigging, e.g. tying a block, shackle on a carriage etc.

Skylines

Perhaps the most difficult mathematical calculations apply when considering skylines or ropes spanning between the two points. Yet these are key uses of wire ropes in this Seminar. The correct curve adopted by a rope suspended between two points is called a catenary. Accurate calculations of loads relating to the catenary are today undertaken on computers. I am not a computer and therefore must look at a simpler method. First the key definitions:

Span	The horizontal distance between the supports be they over a block or tied to a fixed anchor.
Chord	A straight line between the supports.
Deflection or Sag	The vertical distance between the chord and skyline at mid-span. Usually expressed as a percentage of the horizontal span.



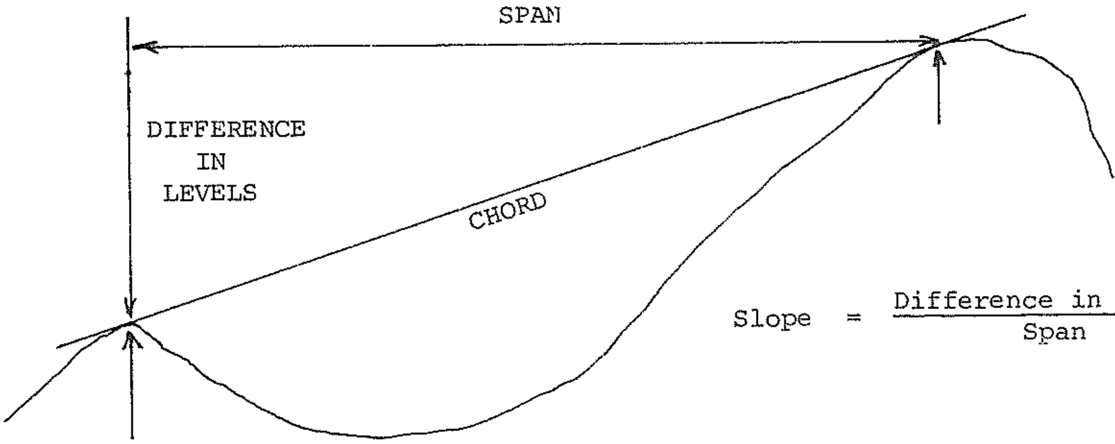
$$\text{Deflection} = \frac{\text{sag dist.} \times 100}{\text{span}} \%$$

Deflection unloaded is when skyline rope only is measured.

Deflection loaded is the actual measurement when our logs are suspended at the mid point.

Slope

The inclination of the rope support points or chord. Again usually expressed as a percentage.



$$\text{Slope} = \frac{\text{Difference in Levels}}{\text{Span}} \times 100\%$$

These basic definitions are necessary to the problems related to loads in skylines. It is important, not that you understand how to do the calculations, but that you have an appreciation of the effects of log loads on rope tensions.

The effect of raising a skyline and reducing the sag or deflection is to impose an ever increasing tension load on the skyline rope. What the limiting loads and deflections are is all calculated and plotted in graphical form in reference material. If your employer cannot help, it is available in the LIRA library.

A simplified formula which is close enough is:

$$\text{Tension on rope} = \frac{\text{Slope span or distance between supports}}{8 \times \text{Deflection}} \times \begin{matrix}(2 \times \text{weight of carriage and logs}) \\ + (\text{weight of rope})\end{matrix}$$

For a $1\frac{1}{2}$" skyline over 1500-1600ft, (500 metres) on a 40% slope, loaded deflection 7% or 35m with 3000 kg (6600lbs) tension or line pull due to load alone is approximately 11,000 kg or 22,000lbs. The line pull due to weight of rope along is approximately 6000 kg or 13,000 lbs.

The breaking load or rope is say 84,000 kg.
So the factor of safety is approximately 5.

If the deflection was reduced to 5% or 25m i.e. we lifted the load 10m to clear an obstruction, the total line pull or tension would increase to approximately 24,000 kg or 53,000lbs and the safety factor would be reduced to 3.5. Not only is the safety factor in the rope reduced but the tension or load on the end fittings and anchors is increased by 50%.

The on-the-job logging operator should only need to think about these aspects occasionally unless he is doing his own planning. Then this work must be undertaken well ahead of the operation. For most of todays contractors or crew bosses this work will have been or should have been done by the company planner. The distances and slopes will be set so that when in use, the skyline deflections should never reach the critical limits to lift loads over obstructions.

On request LIRA can provide a list of useful references, but one book which is relatively easy to use is the Skyline Tension and Deflection Handbook from the United States Forest Service.

I am not going to say any more about ropes except to note that for every loaded rope there is a reaction force be it to a deadman, a block, forces on a drum or brake, or down a tree or pole. Remember this when you twitch the load on that little bit more or with that almight jerk.

SESSION V
PAPER II

ROPES AND ROPE FITTINGS

P.J. O'SULLIVAN
Logging Contractor,
Taupo.

As no doubt most of you have gathered listening to past speakers and discussions and especially those who do the work know, extracting logs by means of cable systems is a series of compromises between the possible and the impossible with a lot of common logic and ingenuity.

By now you will all realise the basic requirement is the yarder whether it be simple one drum winch or modern multidrum computor controlled piece of 20th century technology.

Presuming the logs to be gathered are light enough, close enough and clear of obstacles, all that needs to be added to the simple winch is a short length of wire rope. You now have the criteria for tractor or skidder logging. Add some of the foregoing limitations and you have a requirement for a vast amount of special gear, vast amounts of which are available overseas, but only the basic requirements available here are suitable for modern operations.

The rope which is used for running lines must have a number of conflicting characteristics the old compromise rule applies again. It must be flexible enough to bend around the drums and run through blocks yet large enough in the outer wires to stand up to the abrasion and strong enough to withstand the loads imposed by todays modern high-powered fast-line speed machines. When selecting ropes some of the factors to be born in mind are:

1. Capacity of the machine
2. Distance to be yarded
3. Amount of handling by hand
4. Amount of abrasion to be encountered
5. Maximum line pull available
6. Safety margins required
7. Salvage value if any and relation to economical life.

For instance, the 6 x 19 construction rope I use for a mainline has a poor salvage value because of its diameter and stiffness but, because I have men working close to moving ropes, I must have safe margins in the condition of the rope. A 6 x 31 rope would have a better resale value but is more expensive to begin with and suffers more damage.

On the other hand, my haulback lines have a good salvage value because of their smaller diameter and because they are working under lighter loads less damage is experienced to the outer wires therefore, I purchase 6 x 31.

Once the haulback sizes get over ½ inch diameter, it is preferable to have a straw line. This needs to be strong enough to pull the haulback around the necessary distance but light enough to handle by the least number of men. If the diameter becomes too small, difficulties occur because of plaiting up and twisting. After watching American operations, I have come to the conclusion that we use too light a straw line here. Whereas most of our large haulers in

New Zealand use 3/8 diameter strawline, the same machines in the Pacific Northwest use 7/16. They have more labour in their rigging crews hence they can handle heavier strawline.

An invaluable aid to the strawline is a number of sections complete with coupling hook and loop which, when coiled on a suitable apparatus, can be handled by one man. We find 300ft. to be ideal.

When making a spooling device, a good point to keep in mind, is that the coil should not hang below a man's hips when he has the coil over his shoulder.

Where there is a danger of hooks coming undone, especially in steep country, we use groumets instead of hook couplers.

Owing to the number of groumets, one is constantly removing from the strawline system, we have added a hand operated small diameter rope cutter to our hand tools and I consider this one of the most time saving tools on the landing.

The next requirement is haul back blocks or if the machine to be used is not a self contained tower model, lead blocks.

In general it is recommended that the sheave diameter should be in excess of 20 times the diameter of rope to be used in it but a little mental arithmetic soon conjures up the picture of a man trying to carry a 20" sheave block around so for other than lead blocks which can be carried fitted to the machine or mobile portable tailspars used, the compromise rule must be used again.

The rule now becomes what is capable of being carried by a man yet can stand the strain imposed by the haul back. Thus, for the Kiwi packhorses we consider the biggest sheave that can be incorporated into a block that is going to weigh 90lbs. I have been assured that our Aussie friends across the Tasman would need them much lighter. We seem to have settled for 14" diameter although I believe the weight is coming down and I saw a good range of 14" sheave blocks in North America which only weighed 50lbs.

It is essential that the removable parts of this block be kept to a bare minimum as there is a tendancy to loose pins and keepers but the block hanging system must also be able to be manipulated easily by hand or otherwise much valuable time is lost on track changing.

On my operations we usually have a heavy duty pack frame available as it makes long block humps a little easier on the man. I have often dreamed of a gas fitted balloon which would give the block a little bouyancy so as a man could walk along and just guide it with one hand. It could also carry coils of strawline.

Strops to hang the haulback blocks have to be as large as the haul back and long enough to able to hang the block in both eyes. We use a strop which is long enough to go twice around the average stump we are likely to encounter. This ensures that we don't get the odd stump that the strop won't fit. I believe there are webbing belts available now which are strong enough. These would be very valuable in thinning operations where trees that must not be damaged are used as tail holts. I have seen steel cleats used for the same purpose to eliminate damage to residual trees.

Butt rigging is the next piece of hardware and if experience is any guide, the most expensive will be the best investment. I was always a little angry about the price of this equipment until I visited a plant where it is made and saw the process used. The separate moulding of all the parts inside one another is a long process and at the end process there is always risks of a total loss of the entire article.

As the butt rigging is going to be used for many years, it must be of high tensile strength to stand the loading, must be very hard to withstand abrasion and preferably able to be lubricated to stop integral parts wearing out prematurely.

Some of the same criteria must be used to select shackles and here I would like to take the New Zealand manufacturers to task. Their shackle pin and bow material seems to be too soft as the abrasion, and impact, and load too often distorts the bow, causes burrs on the pin and wears the pin and bow away.

Sometimes it is necessary to use the gas axe to remove the pin. Another fault is the large threads which allow the pin to drop out after three or four turns.

The well known imported shackle never suffered from these faults. To prevent the pins undoing we sometimes hammer the pin tight and then apply grease to the centre part of the pin. This quite often does the trick of stopping the action of the butt hook movement undoing the pin.

Butt hooks are a matter of personal preference apparently, but I prefer the link lock type and I've used these for some estimated 70,000 turns and have lost strops no more than half a dozen times. We do a little maintenance on them to keep the tolerances close.

Strops are another compromise area. Large diameter strops last a long time but become kinky and are hard to handle. They also tend to loose a number of small pieces. Small diameter strops are easy to handle and usually break before getting too kinky.

We usually sabotage broken strops and put figure 8 joins in them. We like the double knobbed type of choker because we can join them together to get the odd log which is out of reach of one choker.

Length of chokers is also a compromise as length allows you more logs from a road but then decreases lift. So the rule becomes good lift, long stops. Poor lift, short strops. I believe that a lot of increased production claimed for gravity carriages in the States comes just as much from the long stops as the gravity return.

A device known as a buzzard hook connecting the haulback to the butt rigging is also a good time saver as time spent doing up shackles and undoing them can mean extra turns of logs.

So much for the basic equipment needed to haul logs with a type of yarder fairly common in New Zealand. There is lots more to be said about other forms such as grapples and smart carriage hardware and other systems but I don't see any great proliferation of them in the near future in New Zealand.

Another area I would like to cover is line changing.

A recent study showed that some 15% of available machine time was being lost by line changing delays. This prompted us to look hard at ways to reduce this delay so we have a number of ways of shifting line.

As we worked the gang with a minimum number of men required in the operating sequence there was no one available to do any preparatory work. The system then worked on all hands helping to shift but as the back blocks are so far from the landing, only the breaking out crew actually did the shifting. Landing crew helped pull the extra strawline needed. The first alternative we tried was using a small chainsaw powered capstan winch. This has lots of advantages when the strawline is difficult to pull owing to a steep uphill pull and allows the breakerouts to obtain the necessary strawline fairly easy but is still subject to delay inherrent in mechanical tools and the blocks and stops still had to be carried and set.

These delays prompted us to use an extra man preferably a senior gang member to preset a shift using a spare set of blocks and coils of strawline.

Although actual time and production comparisons are available we have had rope change times down to under 5 minutes where as other rope shifts ranged up to 40 minutes.

This is the system employed in the Pacific North West.

SESSION V
PAPER III

CARRIAGES, BLOCKS AND HANGERS

R.J. DALLY

General Manager,
C & R Equipment Ltd, Christchurch

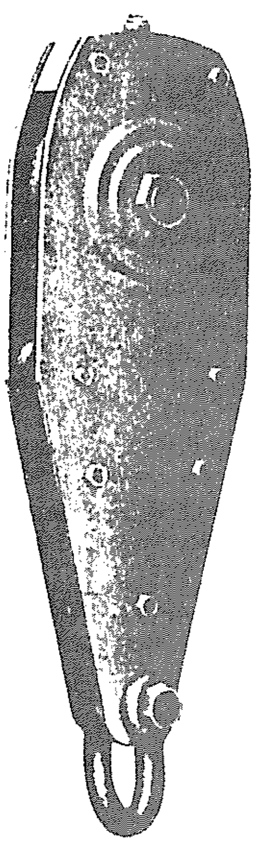
Cable yarding systems utilising carriages are not new to the New Zealand logging scene, but the degree of sophistication now becoming available, throws a different light on their increased capabilities.

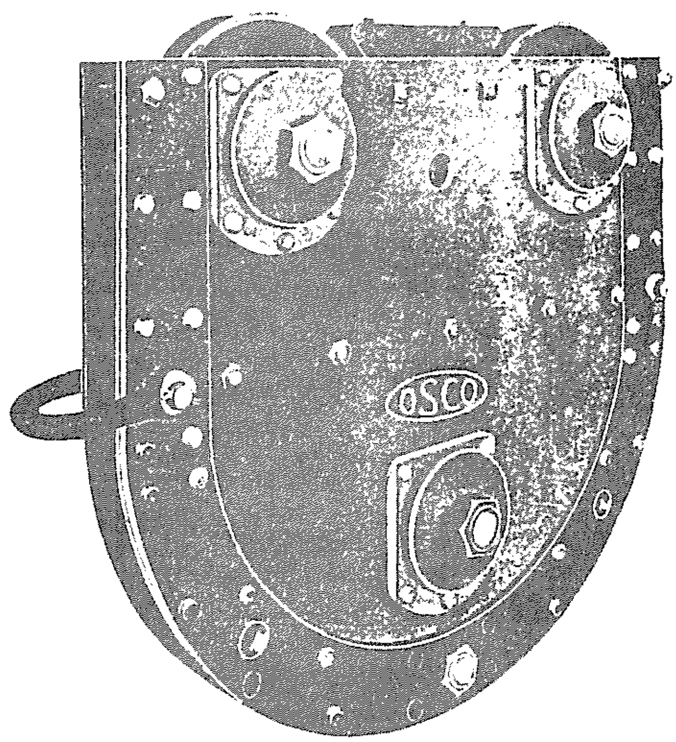
I will attempt to break down the types of carriages now available into four main categories, outlining some of their advantages and disadvantages.

1) Basic carriages
2) Locking carriages
3) Slack pulling carriages
4) Remote control carriages

BASIC CARRIAGES

The basic single, double and three sheave carriages used on the familiar northbend tight skyline, southbend tight skyline or slack skyline are of a very simple construction generally consisting of mild or higher tensile steel side plates, and cast steel rope sheaves, taper roller bearing mounted on individual axles. Upending rollers are generally fitted towing or hanging shackles completing the construction as necessary.





A four drum yarder is required - skyline, mainline, haulback and strawline.

SINGLE SHEAVE CARRIAGE

On lighter skyline work in smaller timber, a single sheave carriage may be used, giving the following advantages.

a) Inexpensive to build and maintain, capital cost $500
b) Light weight, increased skyline capacity
c) Easy to handle

Disadvantages

a) Reduced load carrying capacity due to light construction
b) Increased rope loading and wear
c) Not as versatile as 2/3 sheave carriages.

DOUBLE & THREE SHEAVE CARRIAGE

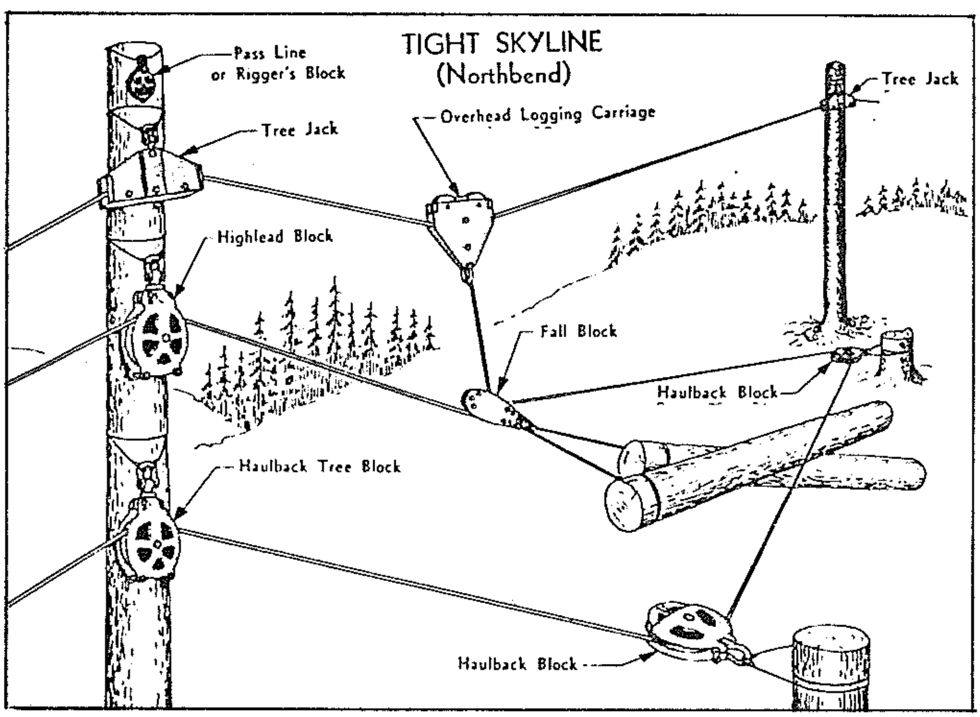
Used on heavier logging, the third sheave being used to gain additional lifting power.

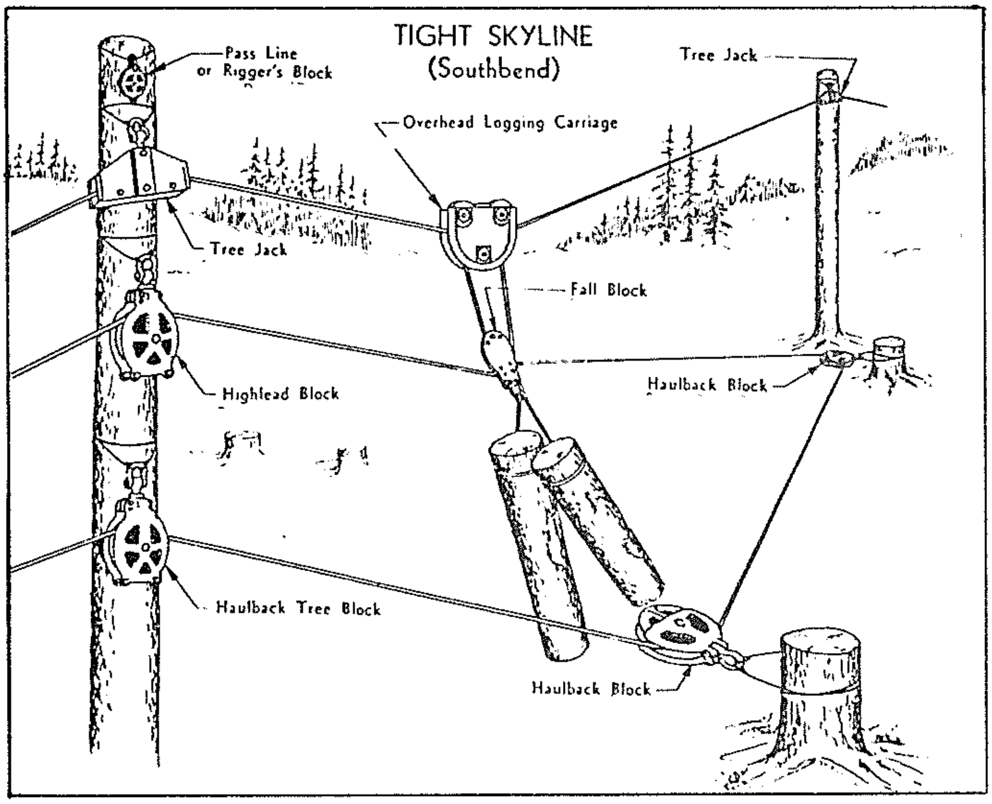
Advantages

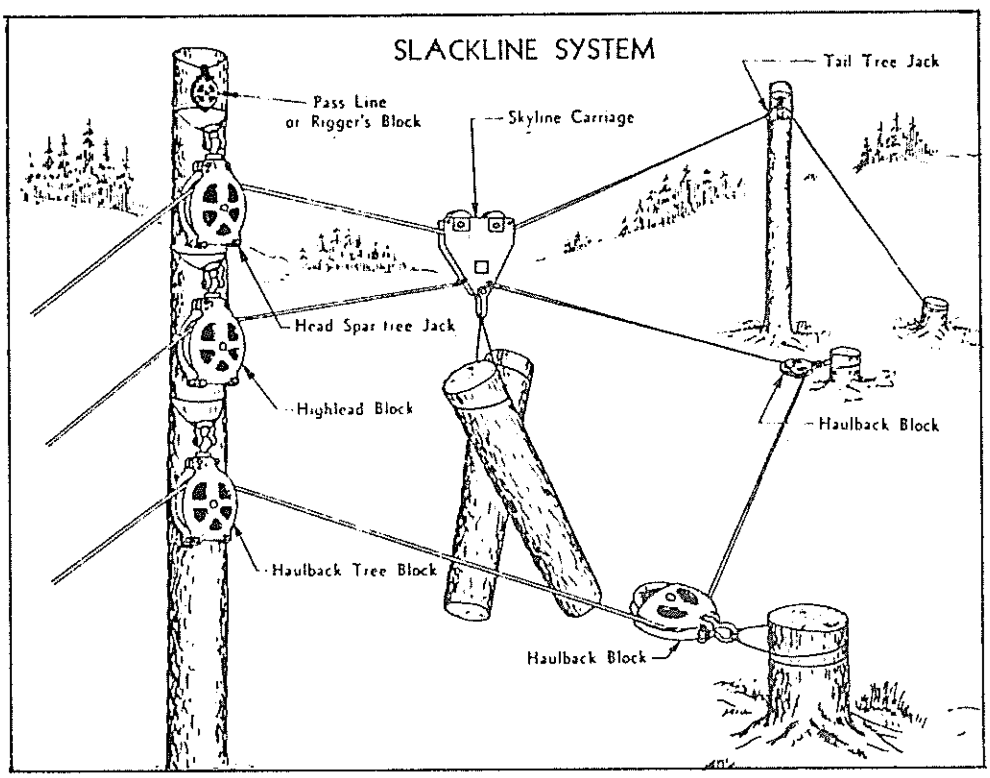
a) Relatively inexpensive to build and maintain. Capital cost $1500.
b) Versatile for several systems (e.g. shotgun)
c) Accepted method with operators skilled at same
d) Increased skyline life due to better loading on 2 sheaves
e) More robust.

Disadvantages

a) Heavier weight reduces skyline capacity
b) Heavy to handle.

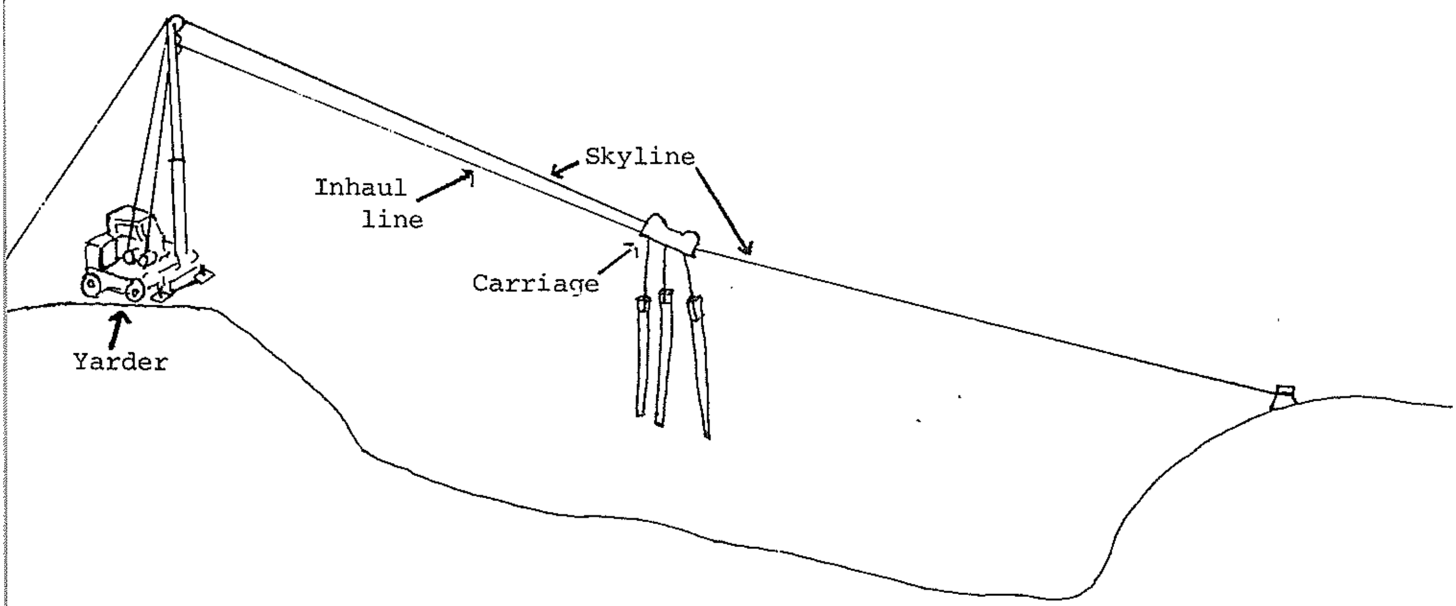



TIGHT SKYLINE
(Southbend)
Pass Line
or Rigger's Block
Tree Jack
Overhead Logging Carriage
Tree Jack
Fall Block
Highlead Block
Haulback Block
Haulback Tree Block
Haulback Block


SLACKLINE SYSTEM
Tail Tree Jack
Pass Line
or Rigger's Block
Skyline Carriage
Head Spar tree Jack
Highlead Block
Haulback Block
Haulback Tree Block
Haulback Block

The above are the most commonly used skyline systems in New Zealand today. A system not commonly accepted or used in New Zealand, but one that I feel deserves better recognition, uses a basic two sheave carriage as described above with a gravity outhaul. The system is commonly known as "shotgun" logging, and is very popular in North America. A 2 drum yarder which may very well be a high lead hauler, supplies the power as indicated in the diagram below.

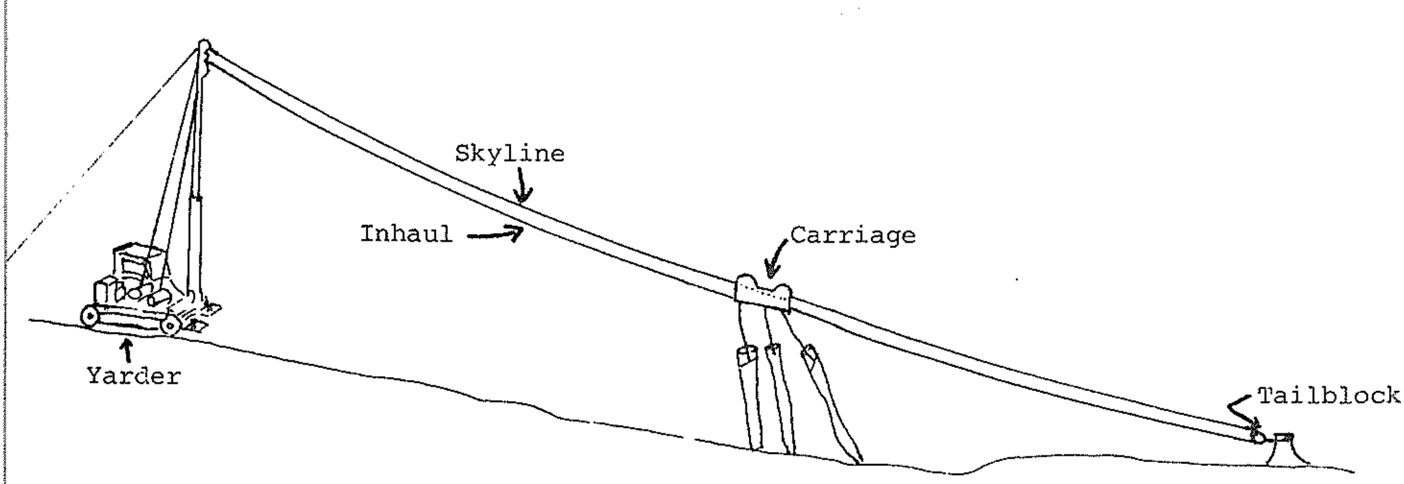
Fig. A



"Shotgun" gravity system for uphill logging using the mainline as a slacking skyline. Carriage uses gravity for outhaul and haulback for inhaul. This appears to be the most popular and fastest gravity system being used, and an obvious advantage of this type of system is the fuel saving obtained.

Other simple 2 sheave carriage systems for 2 drum yarders are as indicated below.

Fig. B

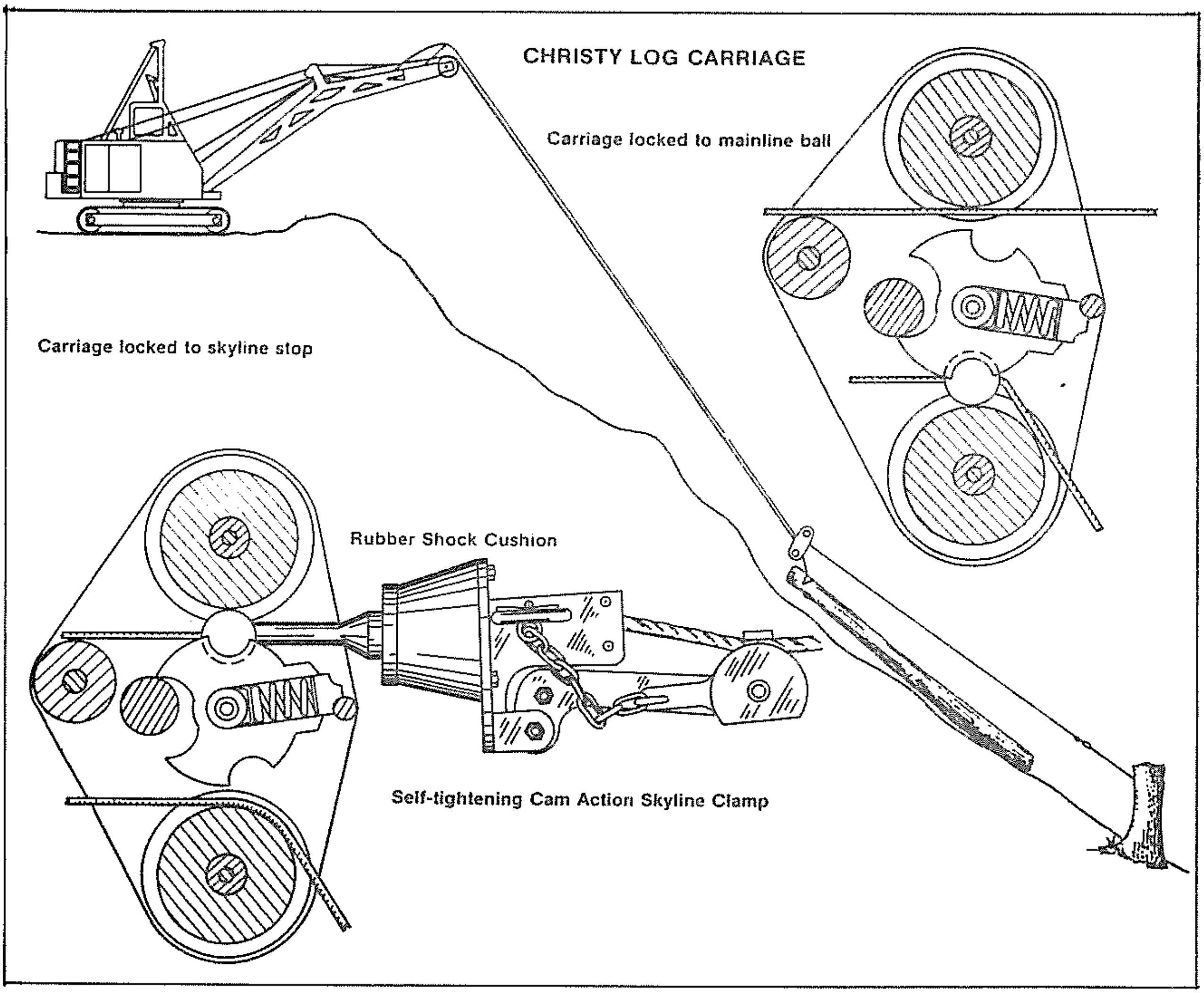


LOCKING CARRIAGES

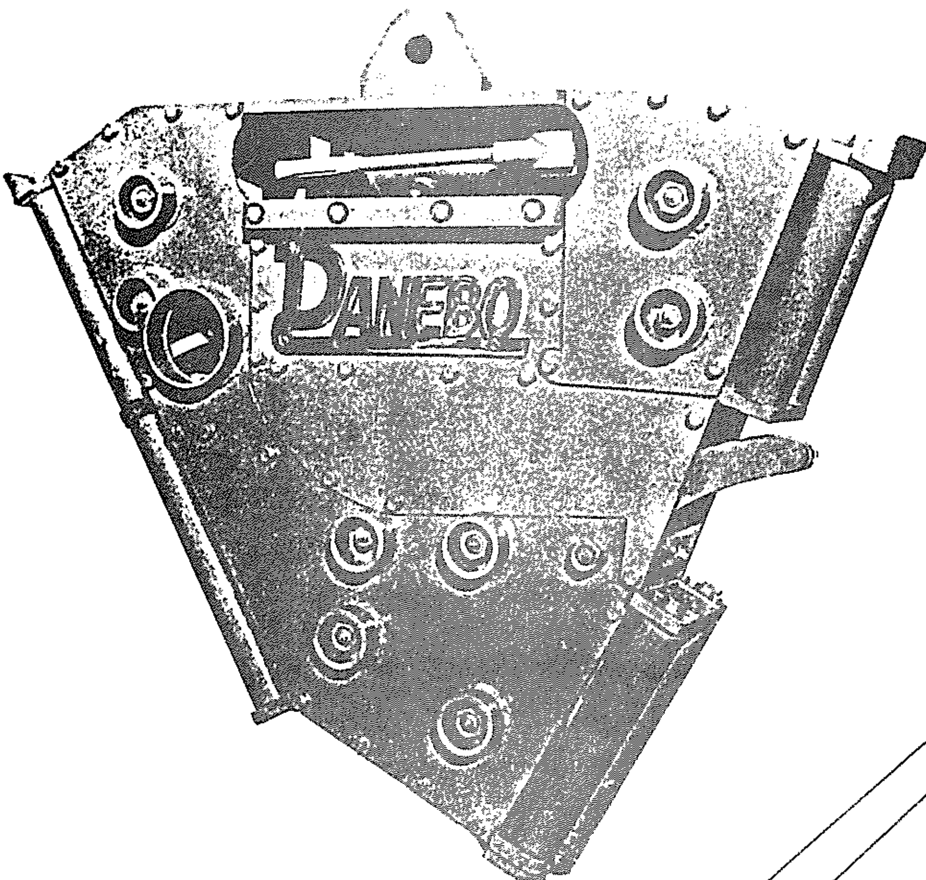
There are two basic systems - one is completely mechanical, such as the Christy and Maki carriages, and the other hydraulic/machanical, as used on the Danebo locking carriage.

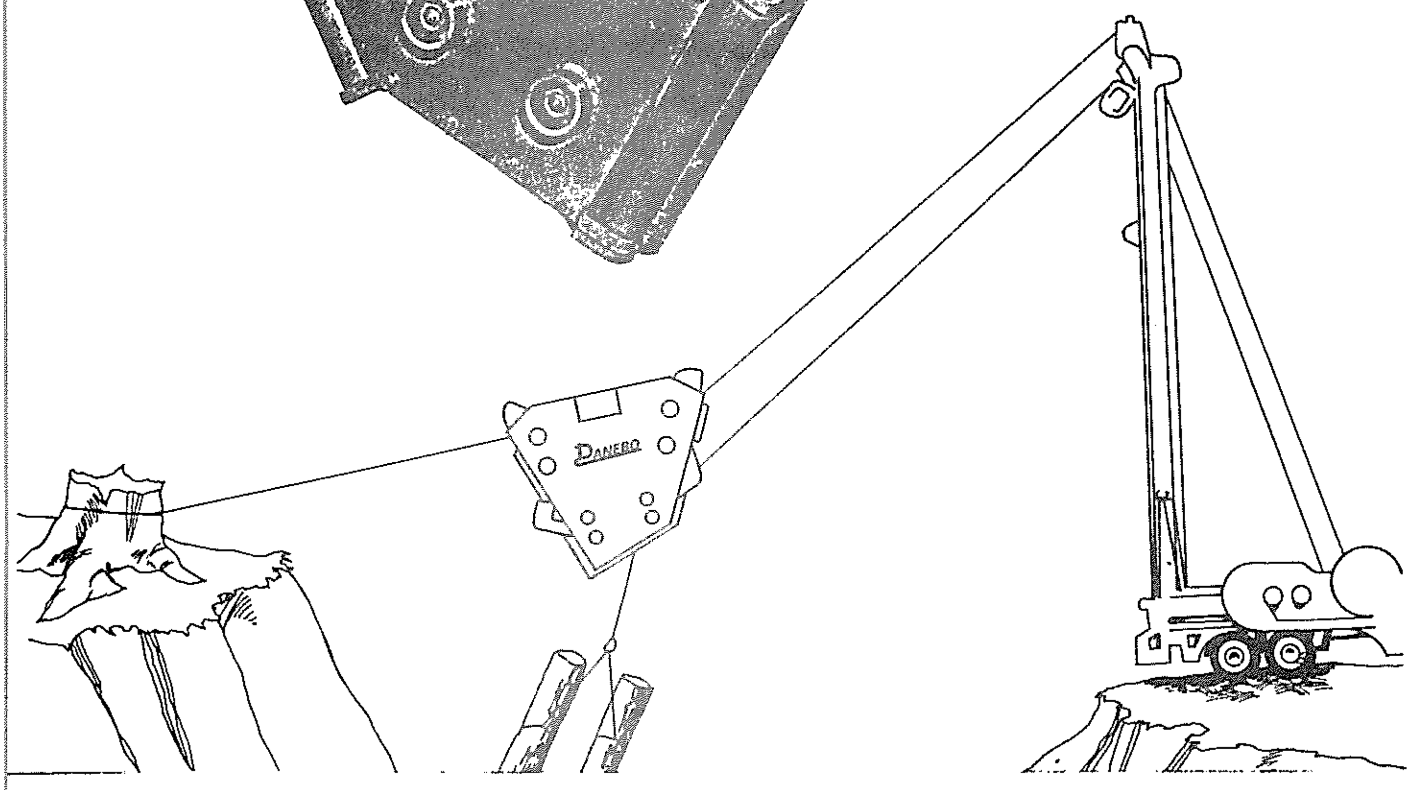
Any of these carriages may be used on a 2 drum yarder, so effectively increase the versatility of same almost to that of a 3/4 drum machine at a fraction of the capital cost.

The entirely mechanical system consists of a self tightening skyline stop or clamp, which is able to be tightened and released quickly without tools. This is positioned on the skyline adjacent to the area to be logged, and is shifted accordingly as the show is cleared. The carriage runs under gravity down the skyline with the mainline locked to the carriage. The carriage hits the skyline stop and effectively locks itself to same whilst automatically releasing the carriage stop on the mainline, which is then able to be fed out laterally to the logs. The chokers are set and the mainline is inhauled until the ball stop on the mainline engages with the carriage stop, the skyline stop is automatically released and the turn of logs is on its way in.



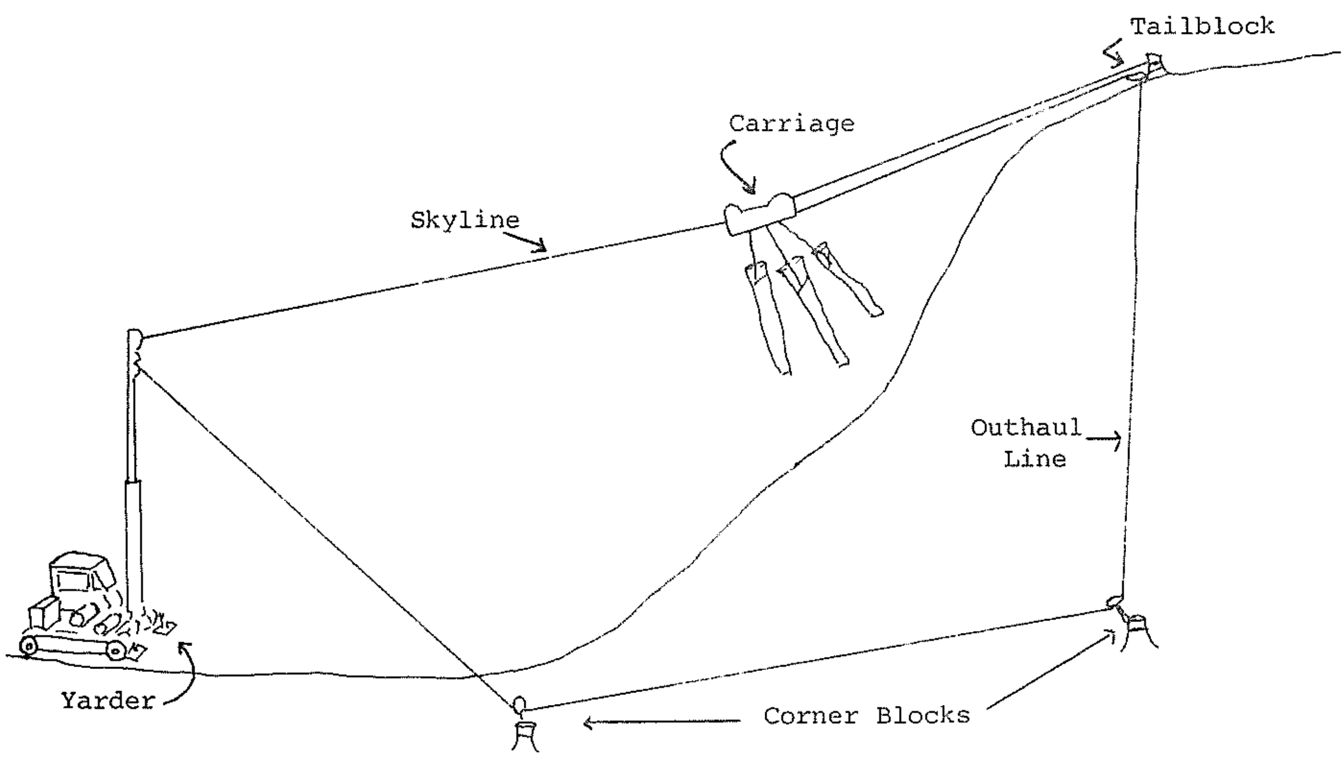
With the hydraulic/mechanical type of carriage, the carriage runs under gravity down the skyline until a radio signal from the choker setter brakes the outhauling mainline and the skyline is lowered to ground the carriage. The choker setter manually pumps up the hydraulic skyline clamp and is then able to feed the mainline laterally out to his logs. The mainline is inhauled until a ball stop above the choker engages with the carriage stop, the skyline clamp is automatically released and the turn of logs is on its way in.





Running skyline system used for all sorts of terrain but most popular for flat ground. The haulback rope is threaded through the carriage, through the tail-block and back to the carriage. The haulback serves as a skyline and as the outhaul line. The mainline connects direct to carriage from the yarder and is the inhaul line. This is similar to the Grabinski highlead system.

Fig C



Gravity system for steep downhill logging using the mainline as a slacking skyline. Carriage uses gravity for inhaul and haulback for outhaul. This system has limitations, in that lift of the skyline must be enough to pick logs free of ground to set in motion and tailblock must be set far enough beyond last logs to maintain weight between carriage and tailblock sufficient to overcome weight of haulback line between machine and tailblock.

Advantages

1) Both the mechanical and the mechanical/hydraulic carriages are relatively simple from an engineering point of view, and have a low capital cost of $3,000 - $5,000.

2) Straight forward maintenance - few moving parts

3) Lateral skidding availability

4) Reduced fuel consumption

5) Can be used on a 2 drum yarder

6) Carriage such as Danebo can be used on other skyline systems.

Disadvantages

1) Generally of lighter construction, limiting use to smaller timber.

2) Safety - manual pumping of skyline clamp could be dangerous, particularly if the carriage lands wrong side up, or in a badly balanced position.

SLACK PULLING CARRIAGES

Generally in two broad areas of design.

a) Simple single sheave on dropline type.

b) More sophisticated multi-drum type.

A The simple single sheave on dropline slack pulling carriage usually limits itself to 100'/125' of dropline available for lateral skidding. The carriage itself is relatively simple, as it is basically a series of sheaves which change rope directions. This carriage is based on a running skyline system and works as follows *(See Fig.1)*:

1) The carriage is pulled out by inhauling the haulback line until carriage is positioned over logs.

2) The dropline is let out by outhauling the mainline and inhauling the slack pulling line simultaneously.

3) Chokers attached to dropline.

4) Dropline is inhauled until logs reach carriage, by inhauling mainline and outhauling the slack pulling line.

5) Carriage brought to landing by inhauling slack pulling line and mainline and outhauling haulback line.

B The mechanical multi drum slack pulling carriage is used on a running skyline system. The mainline and slack pulling line winding on and off separate drums on the 3 drum axle in the carriage. The dropline is on a separate drum on the same axle and normally holds up to 300ft of rope for lateral skidding. The procedure used is basically the same as in (A) above.

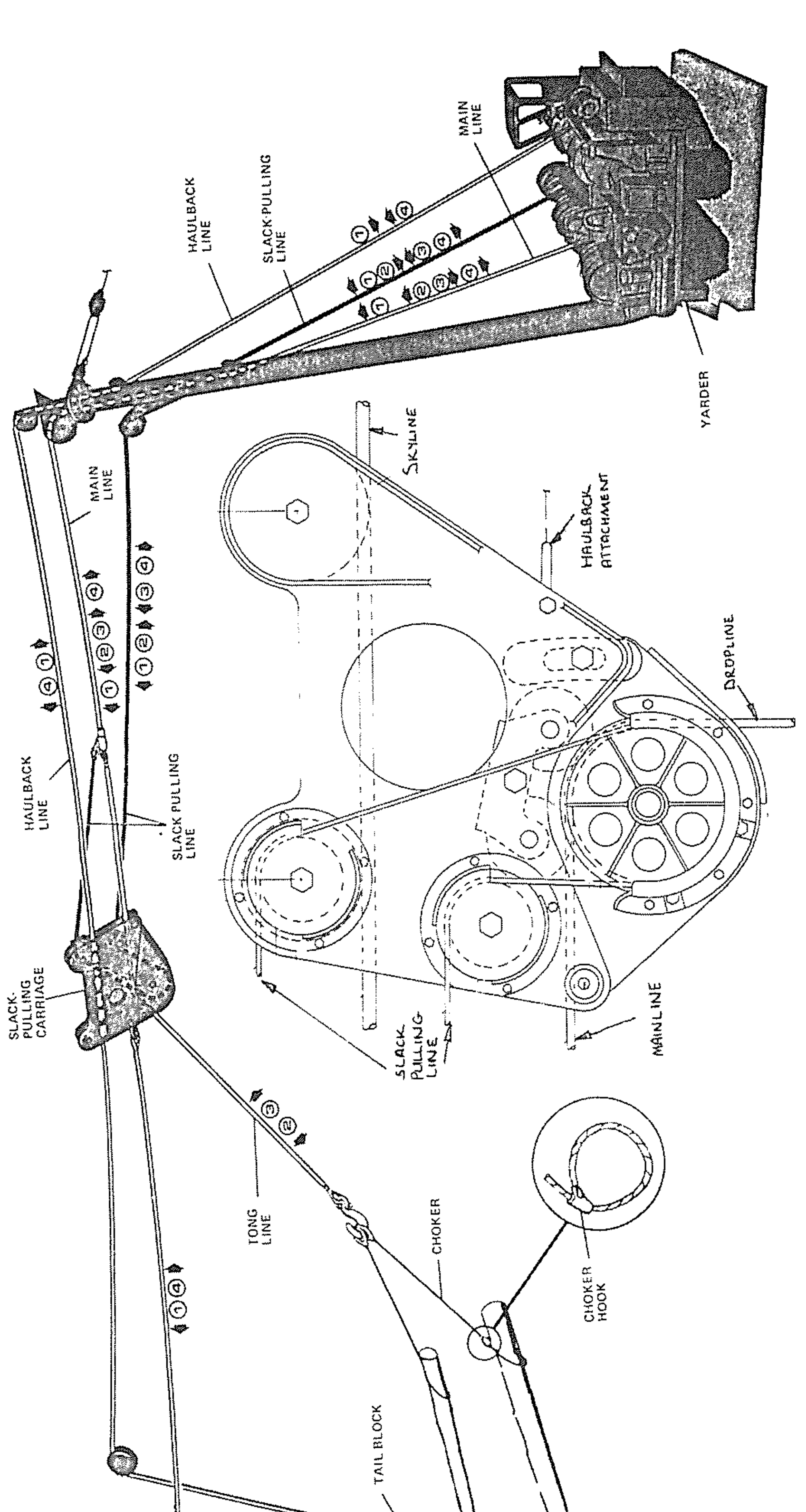

HAULBACK LINE
SLACK-PULLING LINE
MAIN LINE
YARDER
SKYLINE
HAULBACK ATTACHMENT
DROPLINE
MAIN LINE
HAULBACK LINE
SLACK PULLING LINE
SLACK-PULLING CARRIAGE
SLACK PULLING LINE
MAINLINE
TONG LINE
CHOKER
CHOKER HOOK
TAIL BLOCK

FIGURE 1

Advantages

1) Being totally mechanical, these carriages are not too difficult to build and maintain, the degree of cost/difficulty being directly proportional to their design. i.e. Type (A) or (B).

2) Same advantages as the locking carriages but are more versatile, as they can be used for flat, uphill or downhill logging.

Disadvantages

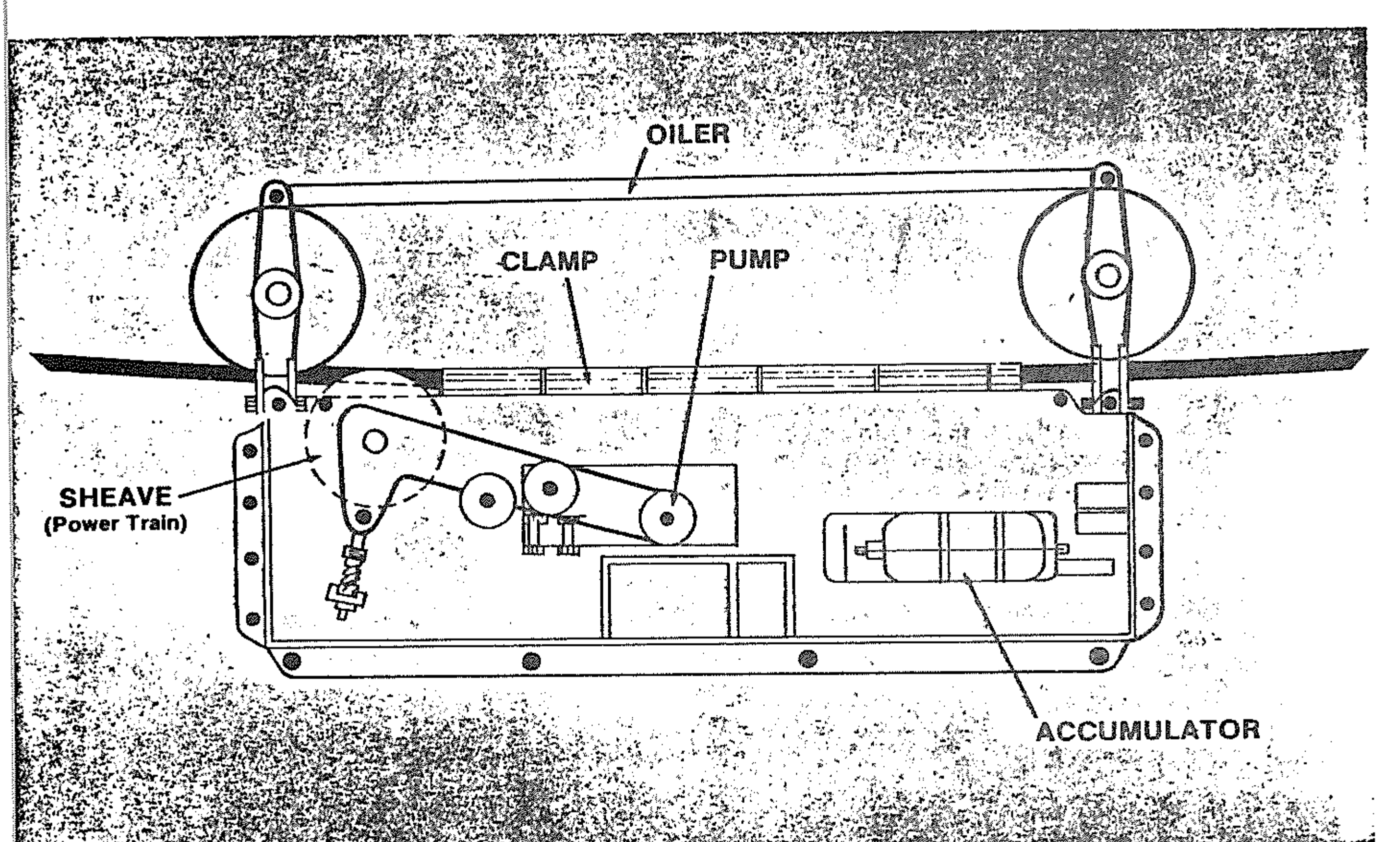
1) Generally used in conjunction with yarders having interlocking drums.

2) Increased operational skill required.

REMOTE CONTROL CARRIAGES

The remote control carriages such as the European Koller and Hinteregger and the American Young or Danebo, may be relatively simple or quite complex combinations of the principles of locking and slack pulling carriages.

Probably one of the most simple examples of radio control on a carriage would be the shotgun type carriage with radio activated hydraulic skyline clamp.

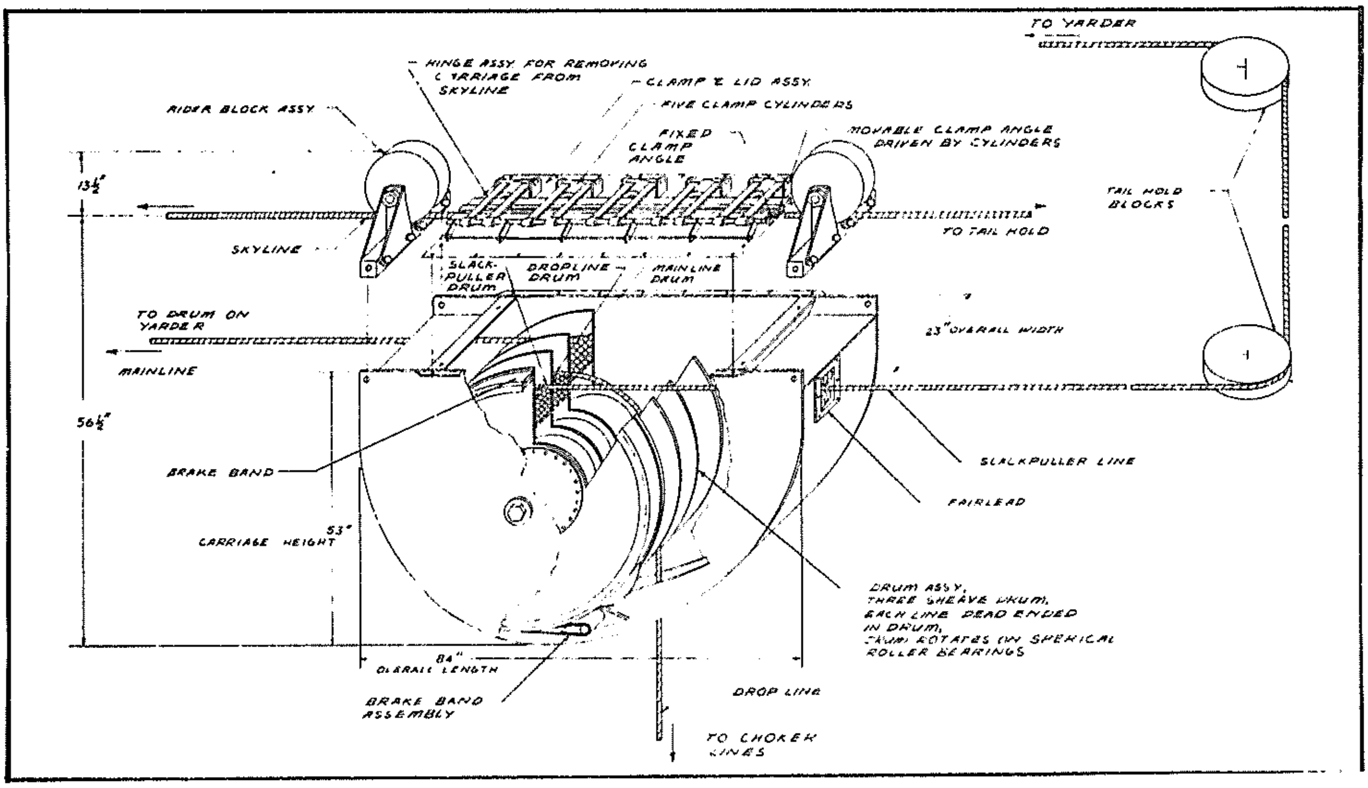


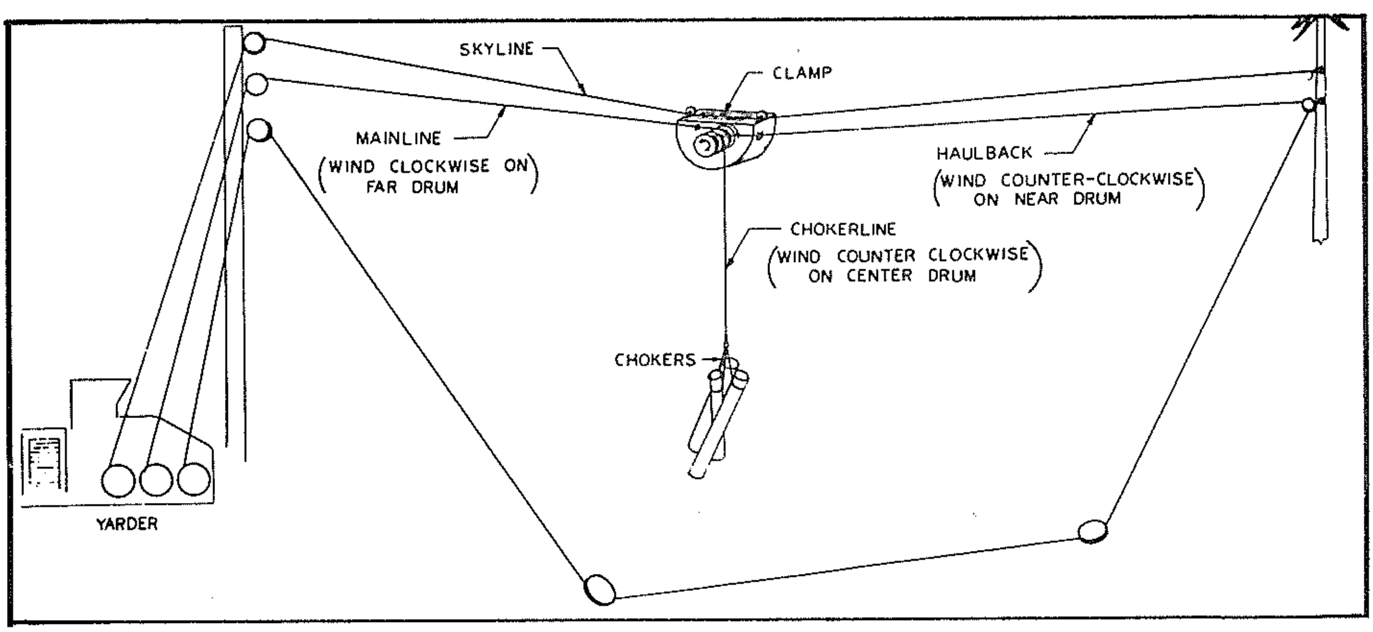
This type of carriage is used on a slack skyline in conjunction with a 2 drum yarder. Gravity enables the carriage to get right out over the skyline tail hold where it is clamped in position by a radio controlled skyline clamp, and the skyline slacked to bring the carriage to the ground.

The hydraulic clamp is generally energised by a sheave operated pump running on the skyline and feeding a hydraulic accumulator.

Once the logs have been chokered the skyline is raised, the skyline clamp released by radio control and the carriage hauled in.

The same principle of radio controlled hydraulic skyline clamp may also be used with the 3 drum slack pulling carriage mentioned earlier.





Remote control carriages may incorporate mechanical or hydraulic clamping of the carriage to the skyline, activated by a reversal of direction of the carriage, or by a time control switch when the carriage is stopped.

Other radio controlled carriages may have such features as built in diesel motor driven dropline drums, radio controlled and similar sophisticated arrangements.

Advantages

1) Increased production due to faster operating cycle of carriage.

2) Can give increased versatility to 2 and 3 drum yarders.

Disadvantages

1) High capital cost and probability of increased down time for maintenance. Approx $25,000 cost.

CONCLUSION

It is inevitable that an increase of cable yarding systems will be phased in, in New Zealand over the coming years due to environmental, ecoligical, and economic factors, and combined with these will be the greater use of carriages.

The cost of the more sophisticated carriages does not appear, in my opinion, in keeping with the technology involved, but appear to include a sizeable sum of development costs.

We either pay these costs or develop our own carriages, based on known systems. We have the engineering skill in New Zealand but unfortunately it is not often coupled with sufficient practical logging experience.

SESSION VI

(Background Paper)

THE MACHINES - WHAT DO WE NEED FOR THE FUTURE?

Chairman :	Bob Gordon, N.Z. Logging Industry Research Assn. Inc.
Panel:	Colin Dickinson, Cable-Price Corporation Ltd. Chris Wade, Lotus Enterprises Limited Pat Hambleton, Dispatch Engineering Milton Bruce, John Burns Engineering Bob Yardley, Wilson Bros.
Attached:	Brief specifications of some cable logging machines currently in use in New Zealand, or available overseas.
Programme:	The aim is to discuss the following aspects: - Mobility options - Engine/Power needs - Transmission options - Drum Set Needs - Spar Options - Basic rigging needs - Control options - Servicing and Maintenance needs.

BRIEF SPECIFICATIONS OF CABLE LOGGING MACHINES
SMALL SIZED HAULERS FOR THINNINGS OPERATIONS

Make	Model	Power	Mobility	Drums	Spar	Weight	In N.Z.
Morito	GS402	60 h.p.	Skids towed	Main rope ½" Tail rope	Nil	2 tons	Yes
Wyssen	W60	57 h.p.	Skids towed	Main rope 5/8"	Nil	1½ tonnes	Yes
Dispatch	1954	64 h.p.	Skids towed	Main rope 9/16" Tailrope Capstan	Nil	2 tonnes	Yes
Timbermaster	4070	60 h.p.	Rubber driven	Skyline Main rope 3/8" Tailrope Strawline	25' steel self raising	6 tonnes	Yes
Baco	SW30	48 h.p.	Skids towed	Main rope 3/8"	Nil	1½ tons	No Made in Switzerland
Urus Unimog	1000/2	100 h.p.	Rubber driven	Skyline Main rope 7/16" Tailrope Strawline	23' steel self raising		No Made in Austria
Igland Jones	Trailer Alp	65 h.p.	Rubber towed	Skyline Main Rope 3/8" Tail rope Strawline Yarding Line	23' steel self raising	2½ tonnes	No Made in Scot-land
Igland Jones	3000/2	50 h.p.	Rubber driven	Main rope 5/16" Tail rope	Steel self raising		No Made in Scot-land
Iwatefuji	Y/280	48 h.p.	Skid towed	Main rope Taile rope Capstan		1½ tonnes	No Made in Japan

Make	Model	Power	Mobility	Drums	Spar	Weight	In N.Z.
Urus Gigant	2500/3		Rubber driven	Skyline Main rope ½" Tailrope Strawline	30' steel self raising	12 ton	No Made in Austria
Pee Wee		110 h.p.	Rubber driven	Skyline Mainrope Tail rope	38' steel self raising		No USA Made
Iwate Fuji	Y103	150 h.p.	Skid towed	Main rope Tailrope Strawline	Nil	9 tons	No Made in Japan

BRIEF SPECIFICATIONS OF CABLE LOGGING MACHINES
MEDIUM SIZED HAULERS FOR HIGH PRODUCTION
EXTRACTION OF SMALL SIZED CLEAR FELLED TREES

Make	Model	Power	Mobility	Drums	Spar	Weight	In N.Z.
Price		190 h.p.	Skids towed	Main rope 5/8" Tail rope Loading rope	Nil	11 tons	Yes
Loggers Dream	LRW	102 h.p.	Rubber driven	Main rope 5/8" Tail rope	30' steel		Yes
Despatch	1557	150 h.p.	Rubber towed	Skyline Main rope 3/4" Tailrope Strawline	Nil	8½ tonnes	Yes
Despatch	1451	150 h.p.	Skid towed	Main rope 7/8" Tailrope Strawline Loading line	Nil	11½ tons	Yes
Wilson	1960	150 h.p.	Skids towed	Main rope 1" Tail rope Strawline	Nil		Yes
Skagit	SJ4	165 h.p.	Rubber driven	Main rope 7/8" Tail rope Strawline	40' steel swinging spar	25½ tonnes	Yes
Wilhaul	1347	130 h.p.	Rubber driven	Skyline Main rope 9/16" Tail rope Strawline	30' steel self raising		Yes
Ecologger	1977	130 h.p.	Rubber driven	Main rope 5/8" Tailrope Strawline	42' steel self raising	14 tonnes	Yes
Little Giant		140 h.p.	Rubber driven	Main rope 3/4" Tailrope Strawline	42' steel self raising		Yes

Make	Model	Power	Mobility	Drums	Spar	Weight	In N.Z.
Skagit	GT4	320 h.p.	Rubber or tracks driven	Main rope 7/8" Main rope 7/8" Tailrope Strawline	55' steel swinging boom	66 tons	No USA made
Madill	044	425 h.p.	Track or rubber driven	Main line 1 1/8" Tailrope Strawline Topping Line	60' steel swinging boom		No USA made
Madill	052 Tension Skidder	535 h.p.	Track or rubber driven or towed	Main line 1 1/8" Tailrope Strawline Slack pulling line	90' steel self raising		No Canadian made
Berger	Marc 2R	425 h.p.	Rubber driven	Main rope 1 3/8" Tailrope Strawline Skidding Line	110' steel self raising	80 tons	No USA made[1]
Steyr	KSK16	250 H.P.	Rubber driven	Skyline Main rope Tailrope Strawline	52' steel self raising		No Germany
Washington	208/110	500 h.p.	Rubber driven	Skyline Mainline 1 3/8" Tailrope Strawline	110' steel self raising	82 tons	No USA made
Washington	TL6 Trak Loader	240 h.p.	Track or rubber driven	Mainline 1" Tailrope Strawline	27' steel swinging boom	52 tons	No USA made
Lynwood	Porta Tower 90	300 h.p.	Tracks driven	Main rope Tailrope Strawline	90' steel self raising	53 tons	No USA made
Skookum-Tyee	K177	300 h.p.	Tracks driven	Main rope Tailrope Strawline Skidding line	120' steel self raising		No USA made

BRIEF SPECIFICATIONS OF CABLE LOGGING MACHINES
LARGE SIZED HAULERS FOR HIGH PRODUCTION
EXTRACTION OF LARGE SIZED CLEAR FELLED TREES

Make	Model	Power	Mobility	Drums	Spar	Weight	In N.Z.
Hayes	1953	200 h.p.	Skids towed	Skyline Main Rope 7/8" Tailrope Strawline	Nil		Yes
Washington	1907	300 h.p.	Rubber towed	Main Rope 7/8" Tailrope Strawline	Nil		Yes
Skagit	SJ7R	220 h.p.	Rubber driven	Main rope 1" Tailrope Strawline Topping	40' steel swing boom	54 tonnes	Yes
Berger	Porta Tower	220 h.p.	Rubber towed	Main Rope Tail Rope Strawline	85' steel self raising		Yes
Westminster	1964	280 h.p.	Tracks towed	Skyline Main rope 1" Tailrope Strawline	Nil	37 tons	Yes
Dispatch	1976	420 h.p.	Tracks towed	Skyline Mainrope 7/8" Tailrope Strawline	Nil	28 tons	Yes
Madill	009/3	450 h.p.	Rubber or track driven	Mainline 1 1/8" Tailrope Strawline	90' steel self raising	48-58 tons	Yes
Madill	071	284 h.p.	Tracks driven	Skyline Mainrope 3/4" Tailrope Strawline	48' steel self raising	33 tons	Yes
Thunderbird	Mobile yarder	320 h.p.	Tracks driven	Skyline Mainrope 3/4" Mainrope 3/4" Tailrope Strawline	45' steel self raising	38 tons	No USA made

SESSION VII
PAPER 1

CABLE SYSTEM PLANNING

D. NEILSON

Logging Supervisor
Kaingaroa Logging Company
Murupara

INTRODUCTION

The planning or engineering of any logging system is the interface between the production requirements, machine capacity, economics, multiple land use and environmental concerns. The logging planners job is to ensure that an area can be harvested and meet resource objectives, using the available equipment and practices.

Cable logging systems are almost invariably more expensive on a unit cost basis than conventional ground skidding systems and so they are not generally used by choice. Problems of topography, access or sensitive ground conditions in fact force operators into cable systems.

Because cable equipment is used in the most difficult areas, operators have less flexibility than in conventional systems and skilled planning is essential if these systems are to be used efficiently.

PLANNING SEQUENCE

Most planners follow through a sequence of decision making, beginning with the selection of an area to be logged and ending with the final logging pattern established, road location completed, equipment to be used selected and production estimates produced.

I will discuss some aspects of the planning sequence, along with techniques which can be used to assist the planner to best achieve his goal.

MACHINE SELECTION

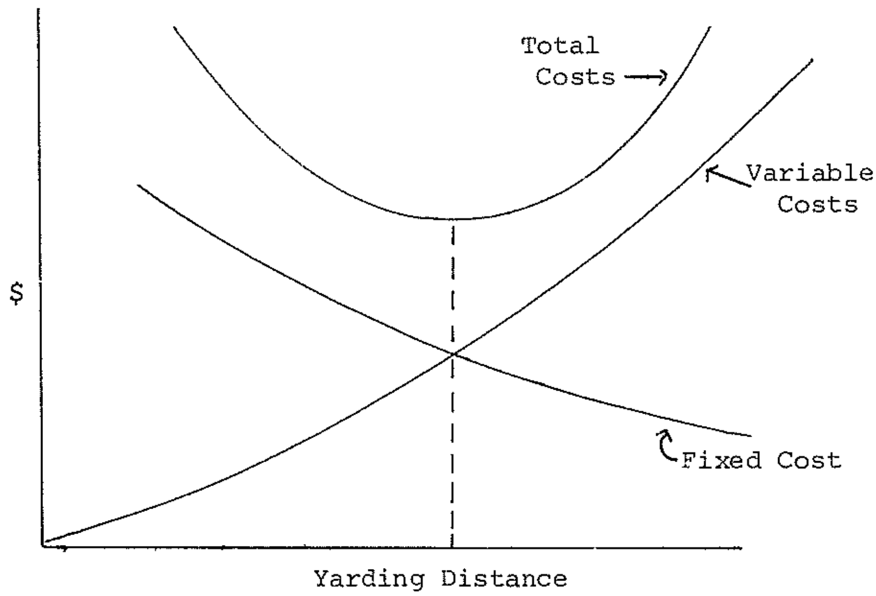
(a) Optimum Yarding Distance

The selection of a piece of equipment to harvest any area is dependent upon:-

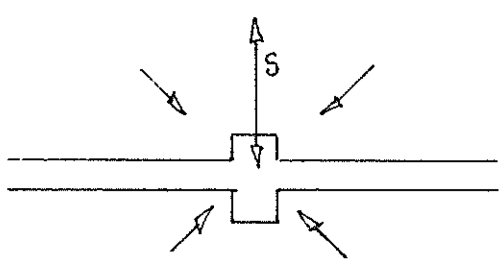
a) The equipment available
b) The physical limitations of available gear
c) The most efficient use of available gear

The logging planner often has little influence, in the short term anyway, over available equipment or its physical limitations. However, he may be able to determine the most efficient use of the gear he has by considering the "optimum yarding distance" for any piece of equipment. In practice the actual yarding distance is often fixed by topographical features - ridges, gulleys, streams etc. but an idea of the optimum yarding distance for a machine can assist him in equipment selection.

The theory behind yarding distance calculations was developed by Mathews, is simple and has some limitations. However, used as a guide can be a useful tool. To achieve the minimum logging cost, the planner must determine the yarding distance such that the fixed + variable costs of yarding are at a minimum:



Example: Consider an ideal skyline yarding layout



let r = road cost per unit length

L = Landing Construction and rigging cost

V = Volume/unit area

C = Yarding cost per unit vol/per unit length.

AYD = .667 x S

Total Cost = Fixed Cost + Variable Cost

$$= \text{Yarding Cost} + \frac{\text{Roading Cost}}{\text{Volume}} + \frac{\text{Landing + Rigging Cost}}{\text{Volume}}$$

$$\text{T.C.} = .667\,CS + \frac{2rS}{Vol} + \frac{L}{Vol}$$

where Vol = f (V,S)

To determine optimum yarding distance, differentiate, set to zero and solve for S.

(b) Power Requirements

Another guide to determining the correct machine to use in any area is the potential inhaul speed possible with the available horsepower. Horsepower requirements can be estimated by

$$HP = \frac{(\text{Weight of logs} + \text{Carriage}) \times (\text{Vertical Speed})}{33{,}000}$$

$$+ \frac{(\tfrac{1}{2}\text{ log weight}) \times (\text{Horizontal Speed})}{33{,}000} \text{ - if dragging}$$

e.g. What horsepower is required to haul a 20,000# load at 500 feet/ minute up a 17° slope? Carriage Weight is 2000#.

Answer is approx. 240 H.P.

(c) System

The common cable systems have been discussed at some length during the seminar. The planner should be familiar with the various systems he has available. A list of design yarding distances for a number of systems is illustrated in Table 1.

The most common system in use is the hi-lead. This system is simple to rig up and operate and can be used with a 2 drum machine.

Generally uphill hauling should be planned for if possible. Hauling uphill provides greater log control, increases production and reduces water run off hazards. Also, uphill hauling reduces the strain placed on a mobile backspar and may eliminate the need for further guying.

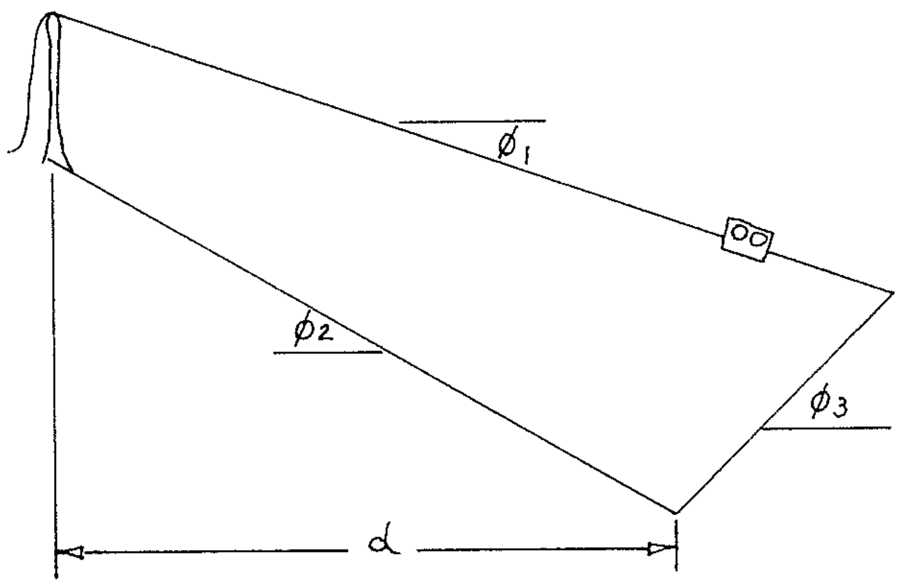
A 2-drum hi-lead machine can be converted to the shot-gun or gravity system.

Operators with hilead machines have found by using a gravity system they can significantly increase production and reduce fuel consumption.

To ensure this system will operate on any setting, the planner must examine the profiles involved. Generally a flyer system will be more efficient than hi-lead if chord slopes are greater than 20% (or 11°). Flatter slopes reduce the speed of the carriage during outhaul to a point where hi-lead may make faster turns.

If the planner contemplates using a flyer system across a gulley he can use the following formula to determine approximately how far the carriage will travel.

$$\text{Distance carriage will roll} = \frac{-b \pm \sqrt{b^2 \quad 4ac}}{2a}$$



Where $a = u = \tan\phi 3$

$b = -2\left\{\frac{WC}{WM}\right\}\tan\phi 1$

$c = d^2(\tan\phi 2 + \tan\phi 3)$

u = co-efficient of friction mainline to ground.

WC = Weight of Carriage

WM = Weight of mainline

TABLE 1: YARDING SYSTEMS CAPABILITIES

ding tem	Harvest Method 1/ CC	PC	Design for External Yarding Distance of: 2/ 200' 600' 1000' 1500' 2000' 3000' 5000'	Limiting Slope % Yarding up	down	Minimum Number of Lines
CTOR				+	-	
phill	x	x	dashed	20		1
ownhill	x	x	solid		35	1
DDERS						
phill	x	x	dashed	15		1
ownhill	x	x	solid		25	1
LBOOM						
phill	x	x	solid	40		1
ownhill	x	x	dashed		30	1
MER w/haulback						
phill	x		solid	55		2
ownhill	x		dashed		35	2
ILE YARDER /carriage						
phill	x	x	solid	75		2
ownhill						
HLEAD						
phill	x		solid	70		2
ownhill	x		dashed		40	2
LINE - LIVE						
phill	x	x	solid	100		2
ownhill	x	x	dashed		100	3
LINE - RUNNING						
phill	x	x	solid	100		3
ownhill	x	x	solid		100	3
LINE - STANDING						
phill	x	x	solid	100+		2
ownhill	x	x	dashed		100 +	2
OON						
phill						
ownhill	x		solid		100+	2
ICOPTER						
phill	x	x	solid		100+	1 3/
ownhill	x	x	solid		100+	1

solid line indicates the preferred direction of yarding

CC = clear cut
PC = partial cut

External yarding distance varies with the terrain, size and type of equipment

Loadline

Yarding up to 3000 ft (900 metres) has been successfully completed although yarding is normally limited by mainline capacity. Generally some sort of skyline system will be required if yarding extends over 1000 ft.

LOAD CARRY CAPACITY

The logging planner should ensure that the cable equipment and system he has selected to log an area can safely handle the load sizes required to meet production goals.

The determination of load carrying capacities is most easily done using any one of a variety of computer programmes written for mini computers. These programmes allow planners to estimate maximum safe loads for standing, live or running skyline systems, given various input parameters, including skyline and mainline sizes, spar height, tailblock height and profile geometry.

A more tedious (but currently more available) method of providing the same answers is to use the "Chain and Board" method.

This procedure is divided into a graphical determination of allowable loaded deflection and a mathematical determination of payload capability.

(a) Graphical Measurements

1. Draw skyline road profile on graph paper.
2. Select headspar and tailspar (stump) locations.
3. Determine the minimum vertical clearance between skyline and ground for carriage and perhaps log clearance. Subtract this clearance from support heights.
4. Draw the chord and a vertical line at mid-span position.
5. Place a chain across pins positioned at the support levels.
6. Hook weight on chain at critical point and lower chain so that the chain at the weight just clears the ground profile. Check other points on the profile to ensure none is more critical.
7. Move the weight to the midspan position and measure the vertical distance between the chain and chord. This is the deflection.

   $$\text{Percent deflection} = \frac{\text{Deflection}}{\text{horizontal span}} \times 100$$

   For profile geometry see figure 1
8. Measure the slope of the span.

(b) Mathematical Measurements (from tables)

as per tables 2, 3 and 4.

Calculate load carrying capacity by determining the safe working load of the skyline used and subtracting the tension due to the carriage and the cable itself.

Once this capacity has been determined the unloaded deflection and tension can be calculated - this can assist correct unloaded tensioning in the field:-

$$\text{Unloaded Tension} = \frac{4 \times L^2 \times W}{32.2 \times R^2}$$

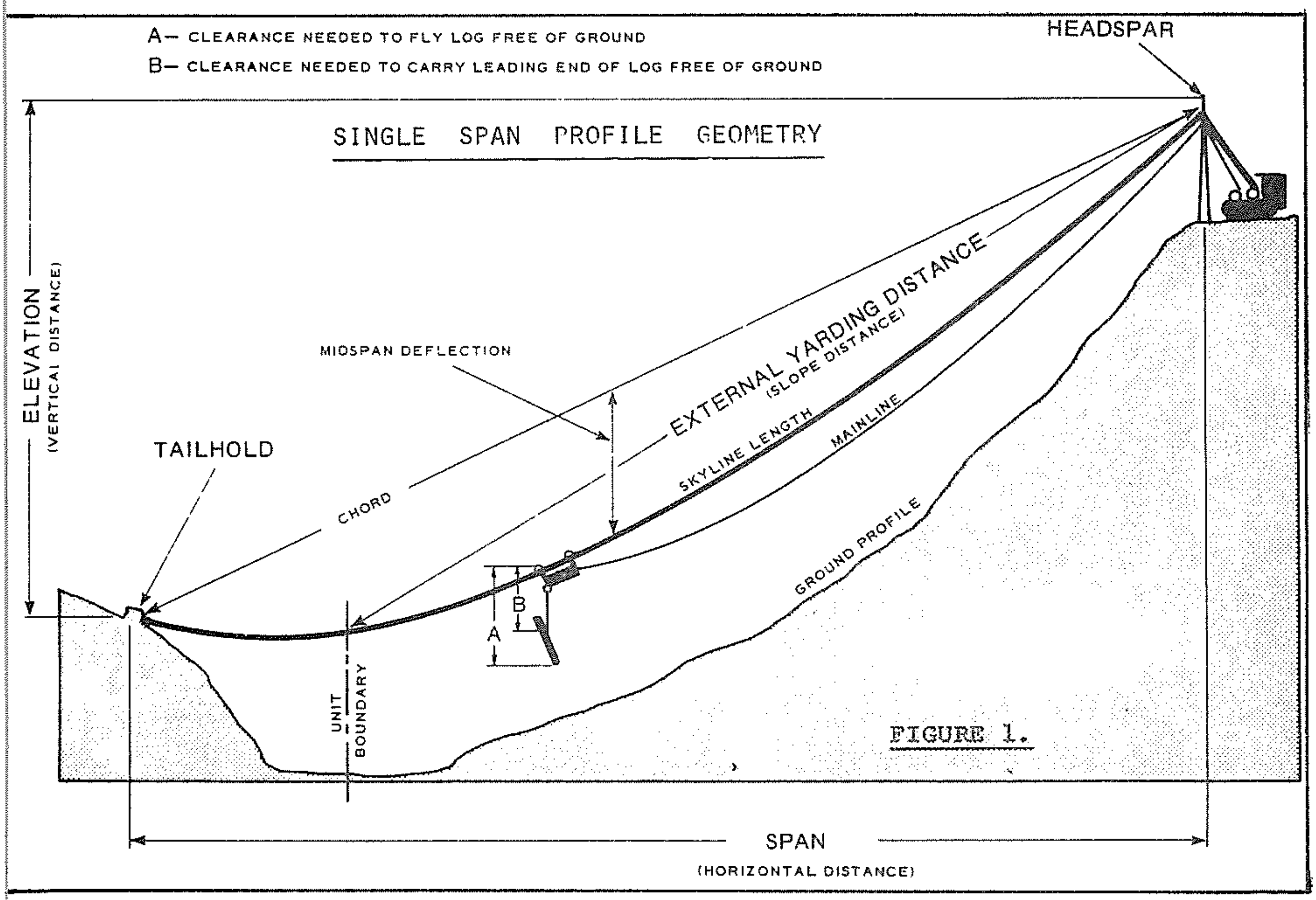


FIGURE 1.

Unit No. ____

Skyline Road No. ____

DETERMINE FROM SKYLINE PROFILE:

Allowable loaded deflection — 16.7 percent

Horizontal span length (one station = 100 feet) — 30 stations

Slope of span — 70 percent

GIVEN:

Cable: Diameter 1 1/2 inches — Weight 4.16 pounds/foot

Breaking strength 228 kips (1 kip = 1,000 pounds)

Factor of safety 3 — Safe working load 76 kips

Skyline carriage weight 5 kips

DETERMINE REMAINING CABLE TENSION CAPABILITY:

Safe working load (given) — 76 kips

Subtract tension due to cable weight FIG A-12, P 111

0.164 kips/sta./lb./ft. x 30 stations x 4.16 lbs./ft. — - 20.5 kips

Remaining cable tension capability — 55.5 kips

DETERMINE GROSS LOAD CAPABILITY:

$$\frac{\text{Remaining tension capability } 55.5 \text{ kips}}{\text{Tension/kip of load}^{*}\ 1.58 \text{ kips/kip}}$$ — 35.1 kips

Subtract carriage weight — - 5 kips

Payload capability — 30.1 kips

DETERMINE UNLOADED DEFLECTION:

Calculate load factor:

$$\frac{\text{Remaining cable tension capability } 55.5 \text{ kips}}{\text{Tension due to cable weight } 0.164 \text{ kips/sta./lb./ft.} \times 4.16 \text{ lb./ft.}}$$ — 81

Allowable loaded deflection — 16.7 percent

Subtract deflection change with load removed (figs. 14 to 29) — - 3.1 percent

Unloaded deflection — 13.6 percent

DETERMINE UNLOADED TENSION USING UNLOADED DEFLECTION (fig. 11 or table 2):

0.186 kips/sta./lb./ft. x 30 stations x 4.16 pounds/foot — 23.2 kips

* Use figure FIG A-13, P 112 when load is not clamped and is partially supported by a snubbing line. Use figure A-14, P 113 when the load is clamped to the skyline.

TABLE 2: SINGLE SPAN WORKSHEET

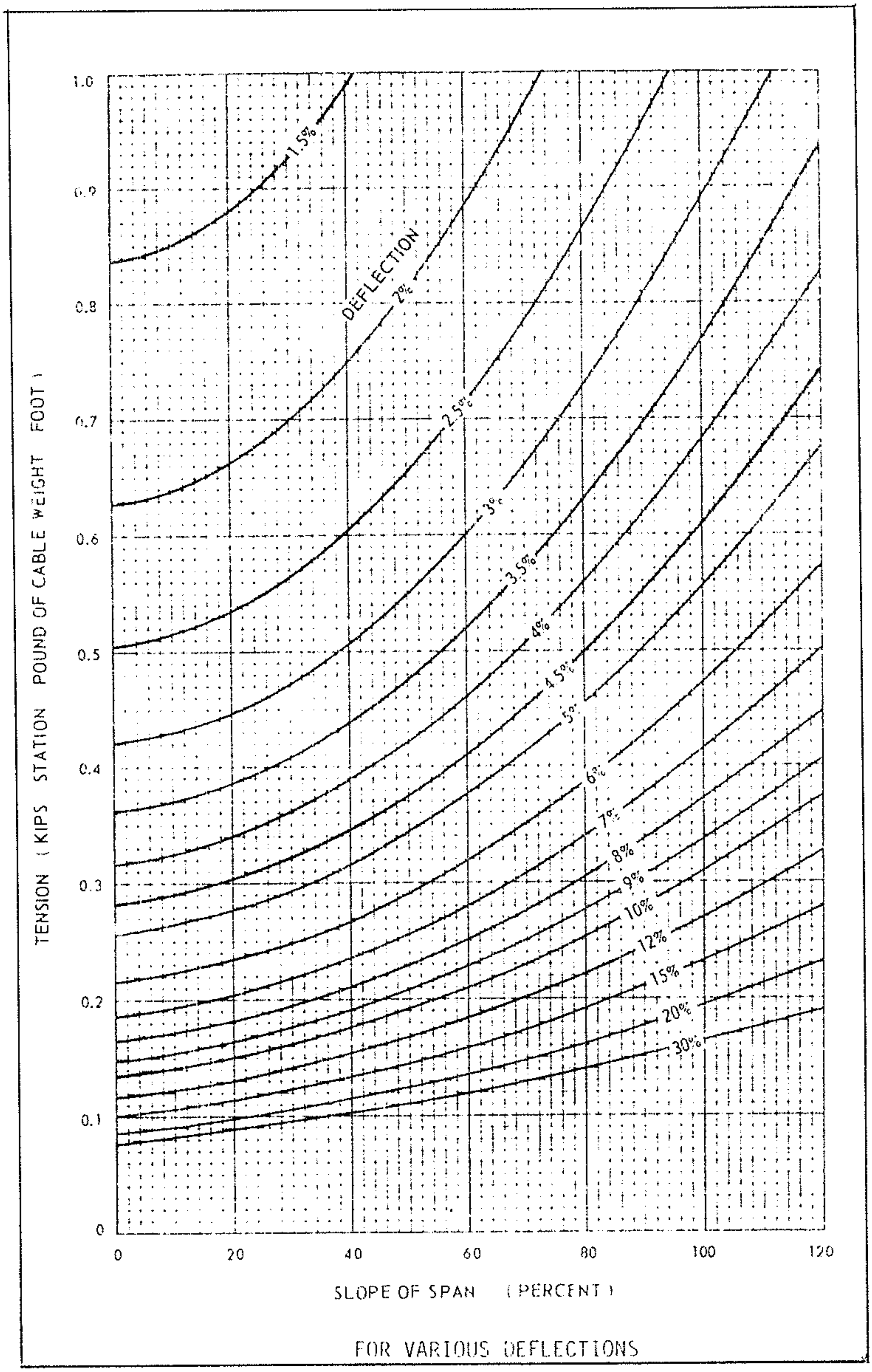


TABLE 3: UPPER-END TENSION DUE TO CABLE WEIGHT vs SLOPE OF SPAN.

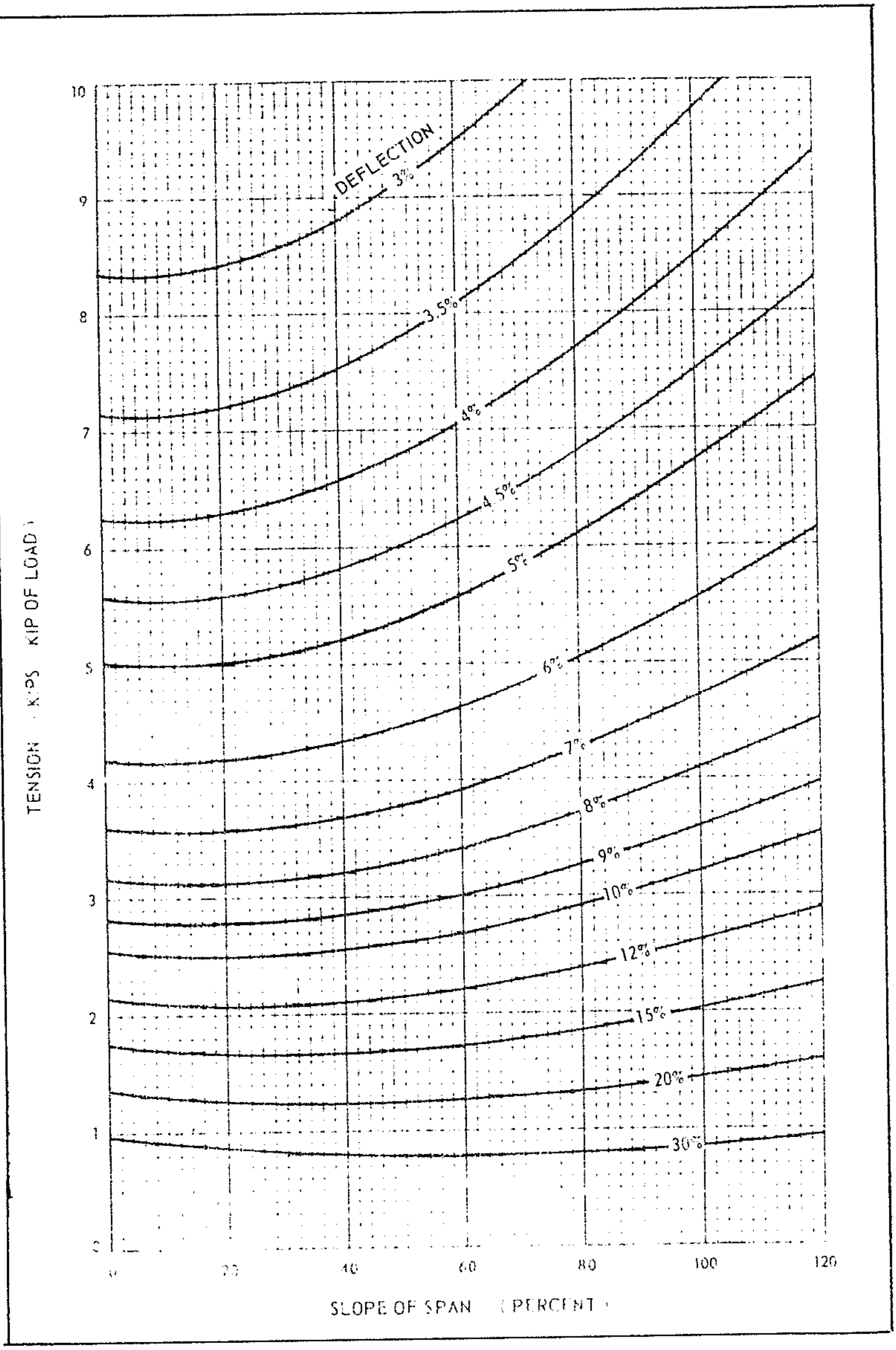


TABLE 4: TENSION DUE TO MIDSPAN LOAD vs SLOPE OF SPAN FOR VARIOUS DEFLECTIONS (CARRIAGE NOT CLAMPED TO SKYLINE)

Where L = Skyline Length

W = Unit Weight of skyline

R = Round Trip time for wave.

Landings

Little consideration has been given to landing design in the volcanic plateau area as construction costs are low and generally an abundance of guy trees have been available. However, in areas where skid construction costs are high and landing areas are limited, planners should be familiar with minimum requirements.

Landing Size - Example

	Square Lead	Straight Lead
Butt Rigging	9	9
Log Length 3/4 on landing	30	30
Yarder Undercarriage	12	40
Clearance between yarder and log	3	3
Total Length:	54	82

To this must be added room for loader requirements, through traffic, decking and the effect of steep ground.

Landing Position

Guy stumps should be selected so that there is an angle of 60° or less between guylines and the ground - examples of good and bad landing positions are shown in figure 2.

Planners should also be familiar with the effects that various anchoring and guying configurations have on the stability of the system and allow for alternative methods such as deadmen or rock bolts if satisfactory anchor points do not exist.

Figure 3 shows two examples of the effects of anchoring commonly used:- the first indicates that tying back to a third stump will not assist in holding the skyline as the tension between the second and third stump will not assist in holding the skyline as the tension between the second and third stumps is negligible;

- the second shows the effect on tying back to a second stump at an angle greater than that of the incoming skyline.

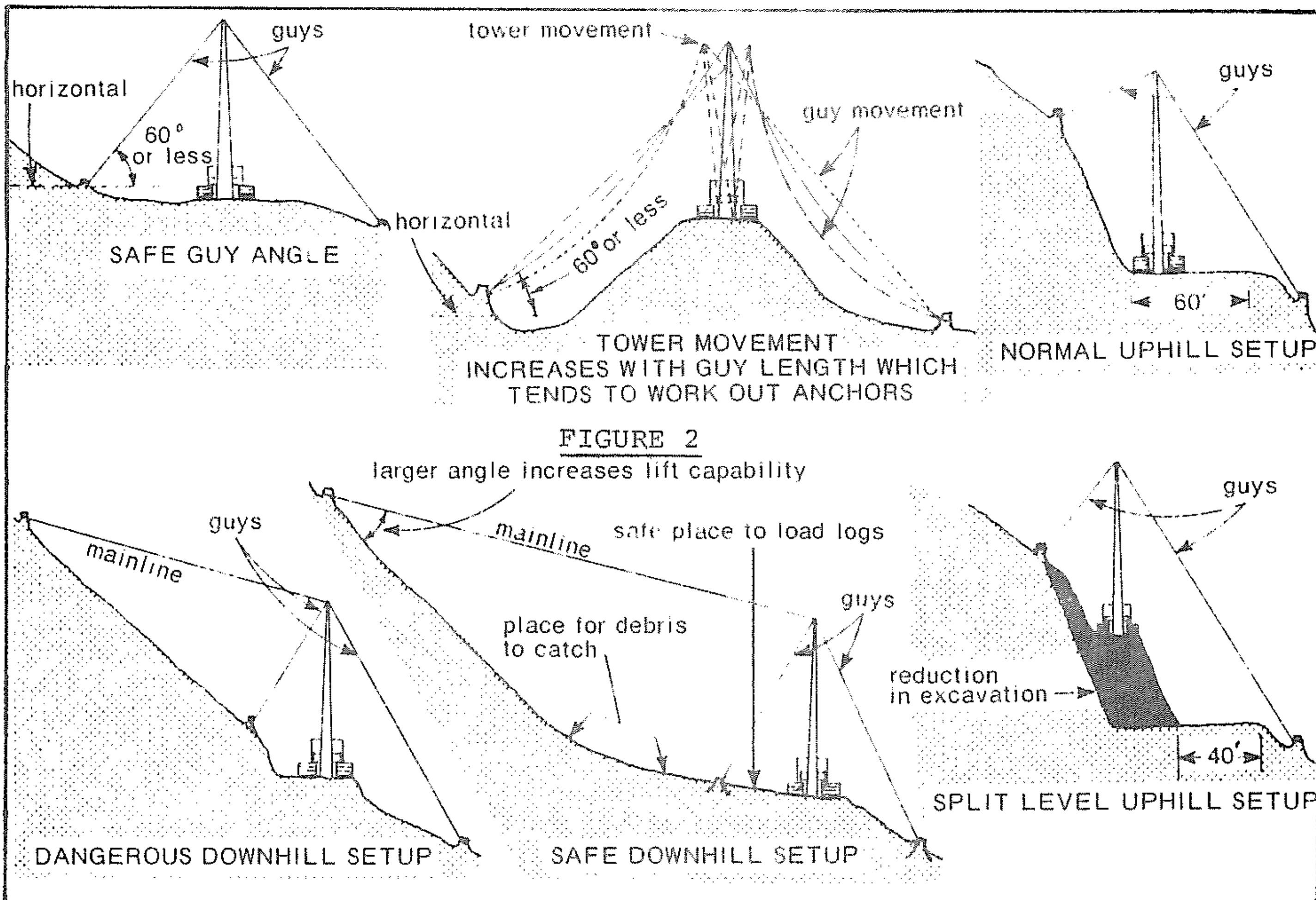


FIGURE 2

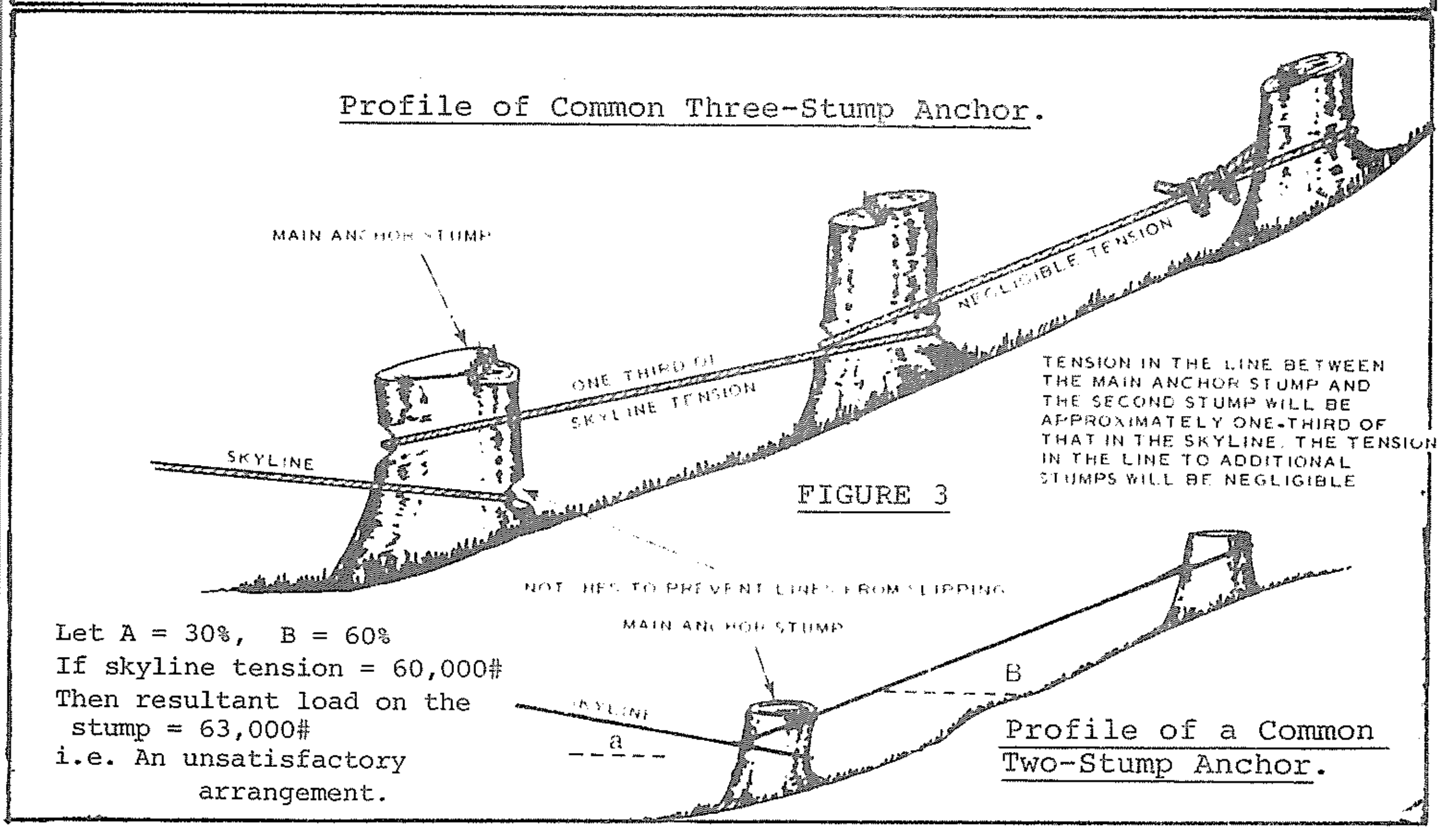


FIGURE 3

ROADS

The planning of road systems is a major exercise in itself and will not be dealt with here in any detail.

However, I will make two comments on planning which should be looked at if necessary during the planning sequence.

1. Yarder Access

   Many of the modern steel tower mobile machines travel with the tower extended some distance in front of the cab. If narrow roads only are established, the geometry of critical corners should be examined to see if the unit can in fact negotiate them. Curve widening formulae can be used to calculate the width of road necessary for any machine given the curve radius, cut bank slope, vehicle geometry and steering cramp angle.

2. Road Network System

   The design of the road system in cable areas is often determined largely by topography - unlike that of tractor areas where often roads are simply straight line links between skids.

   Planners should take both road construction and log transportation costs into account when planning a network.

   Often by spending more money in the construction phase the overall logging cost to the mill may be reduced by a greater reduction in transport costs.

   Publications such as Byrne can be used to determine the trip times for a variety of truck types on different slopes, road types and curve characteristics.

   It has been noted that the majority of logging trucks are traction limited and not power limited. By stabilising short sections of roadway with seal or some other material, grades of 1 in 5 or 6 adverse can be successfully negotiated by conventional trucks.

SESSION VII
PAPER II

FINANCIAL REQUIREMENTS AND COST LEVEL EFFECTS OF CABLE LOGGING SYSTEMS

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INTRODUCTION

In business the story begins and ends in finance. It is the life blood of any enterprise, large or small. Without it nothing happens. Plans remain unrealised, and labour and machines remain idle. Therefore, in any logging system, as in any other business enterprise, it is the financial requirements and the way this requirement is met that becomes important in the overall planning function.

Financial requirements fall into three main streams:

1) Current period finance to cover the current costs of such items as wages, fuels, maintenance and working materials

2) Intermediate finance to cover periodic recurring expenses such as insurance, registration fees, and major repairs and overhauls

3) The longer term finance to cover the capital cost of machines and equipment.

In the long run this finance must come from earned revenue but in the initial stages much of it will have to be borrowed and then paid back with interest.

The significant questions are, how much will have to be borrowed, and for how long?

SYSTEM COST STRUCTURES

The answers to these questions will depend on the structure of the system costs and the allowed period of principal recovery on borrowed monies.

For tractor systems on clearfelling operations the structure of costs is approximately:

Labour	30% to 45%
Operating Expenses	25% to 30%
Capital Recovery	30% to 45%

For two systems, one tractor and the other cable, operating on the clearfelling of comparable piece-size material, the structures are approximately:

	Tractor	Cable
Labour	34%	25%
Operating Expenses	29%	40%
Capital Recovery	37%	35%

This represents quite a distinct change in the financial requirements. The requirements for operating costs in the cable system are greater than for the tractor system, and because of the uncertainty in the regularity of financial requirements in this sector of the cost structure, a higher reserve would need to be maintained. Labour and capital loan repayments are both regular requirements, although each uses a different cycle length on the time scale, and this can assist in forward financial planning, particularly with regard to the rate of accumulation.

The changes shown in the above cost structures give no indication of the comparative capital investment of the two systems. In these examples the initial capital cost of the cable system is approximately 100% greater than the tractor system (note that the comparison is made on the basis of new equipment at current cost).

On the basis of past studies in tractor operations such as increase would demand, at the very least, a 70% increase in the rate of production to maintain a comparable unit cost (1). In this cable system example preliminary study suggests that the increase required may not be so severe as this; the main contributing factor being the extended working life of cable machines. The 1973/74 survey of the logging industry indicated that a service life of 10 years was not uncommon for cable logging machines - some going for a much longer term while for tractors 7 years seemed to be the accepted limit (2). This means that in general terms the capital cost can be recovered over a longer period. The restraints on this advantage will be found in the cost of the longer term financial support, and the impact of the higher level of operating costs.

A tentative assessment on the overall effect of change from tractor to cable indicates that an increase in system costs operating on similar piece- size material will be in the region of 30% to 40%. Thus the given tractor system producing at a unit cost of, say \$5 m^3, would compare with the cable system producing similar material <u>at the same rate of production</u> at a cost of \$6.50 m^3 to \$7m^3.

At the time of writing, detailed knowledge of cable systems, operating methods, and production targets is limited. The FRI harvesting group has studied and analysed tractor logging for nearly eight years, while cable logging studies have only just begun, but, on the basis of the limited number of studies carried out to date, and on stated overseas experience, about a 30% reduction in the rate of production could be expected in cable logging when compared with the rate of production of tractor logging in a similar piece-size situation, hence a further increase in the unit cost can be expected,and in the above example, the higher unit cost of \$6.50 m^3 to \$7 m^3 would increase to around \$9.30m^3 to \$10 m^3 in these circumstances. As a result of these deliberations an increase of 100% in the unit cost of cable production over tractor production should cause little surprise.

The comparable contribution to the given unit costs of the two systems in the above example would be:

	Tractor	Cable
Labour	\$1.70	\$ 2.50
Operating Expenses	1.45	4.00
Capitable Recovery	1.85	3.50
Total	\$5.00/m^3	\$10.00/m^3

FINANCIAL PROBLEMS

In the initial stages of system ownership the cash required to cover the charges related to operating costs and loan capital repayments is often difficult to find from earned revenue (3). This leads to increased borrowing beyond that initially planned. One cause of this is the relatively short period allowed for loan capital repayment when related to the longer term capital recovery of the system, particularly when the capital recovery allowance is an integral part of any contract price formula.

Because of the expected longer life of cable systems the impact of the discrepancy between the rate of cash requirements and cash recovery will tend to be greater than in the shorter life cycle of tractor systems.

A clear and simple statement of the effects of relatively short-term borrowing commitments is given by T. Cohn and R.A. Lindberg (4).

"Although interest paid on borrowed money is one of the lower costs in running a business, small business managers should relate their borrowing to basic financial stratety.

For example, many companies in financial trouble have tried to maximise earnings by borrowing at the lowest rates available in the short-term market, when they should have borrowed for a long period and paid the higher rates. They were caught in the vise of onerous terms for repayment of loan principal and a project that had not produced cash as fast as it was supposed to. A margin for error of 25 to 50 percent in terms of time requirements is simple insurance. The extra interest that may have to be paid for borrowing longer than originally or optimally planned eliminates a lot of sleepless nights"(P. 195).

In spite of the many warnings of the type given by Cohn and Lindberg, the industry continues to be bedevilled by this problem, and a firm and concerted effort is needed to seek and obtain better financial terms that recognises a realistic rate of capital recovery.

In conjunction with this problem runs the likely future problems of finance to cover increased machinery costs and the expected increase in industry activity.

In recent years technical advances and inflation have tended to double the cost of machines from prices paid eight to ten years ago. This imposes an additional strain on available finance, increases the competition for finance, and tends to force up the interest rates. One sector of the forest industry already reports that they are paying 23% interest for borrowed money.

If activity increases in the logging industry it will not be in isolation - other sectors of the industry will also be developing, and laying claim to finance. It is likely that one of the critical prevailing features of the future will be the ability of the industry to attract the finance it will require under terms that it can afford. If this increase in activity is largely carried out by cable loggers, then they will have to bear the brunt of the problem and its cost.

At the present time the initial capital cost of logging systems ranges from $100,000 to $500,000 depending on the type and complexity. This level of capital makes it nearly impossible for the potential sole owner to make a significant personal investment in the initial stages, which has been a feature of the logging industry's historical development.

With the need to find the growing additional finance from sources other than the owner comes the need for a greater degree of managerial proficiency in all phases of system planning and control, for without the ability to demonstrate this skill to potential investors the industry will go begging. This is not to say that all owner-managers of logging systems must become expert exponents in the many disciplines that need to be employed in the planning, development, execution and control of logging systems, but rather that they see to it that the various disciplines they call upon to assist them in their task are fully acquainted with the complexities, difficulties and restrains that erode the efficiency of their operation.

In New Zealand the accounting profession has seen to it that training in the accounting field has contained substantial material related to pastoral accounting because of the significant role that industry plays in the economy. It is up to the logging industry to ensure that it supplies similar adequate information to those accountants and financial advisors they employ if they are to get the greatest benefit from their services.

Past evidence suggests that accounting and financial advisors have not always been well briefed, particularly in the more critical physical aspects of the operation, such as realistic rates of production for given types of material and realistic machine utilisation and availability. A greater degree of co-ordination and co-operation between the involved disciplines is needed if the industry is to improve both its productivity and its profitability.

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(3) T. Fraser, K. Walker 1976 Production, Pricing and Profits - Some problems Facing the Logging Contractor. Forest Industries Review April 1976. NZFS Reprint 1035, No. 3 December 1975 to July 1976.

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SESSION VII
PAPER III

MAN POWER AND TRAINING

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1. MANPOWER REQUIREMENT

When discussing the manpower planning and training requirement for cable logging systems the first step is to determine the number of employees required for particular cable systems and then to look at the types of skill that are required by these employees.

Predicting the number of employees required to service a cable logging system is very difficult as the size of a crew varies from area to area even when the same methods are being used. This variation in crew size results from the different climatic conditions, topography, species logged, and even to a certain extent, the traditional thinking of loggers working in different areas of New Zealand.

The number of men required in a cable logging operation is however, generally in direct proportion to the productivity of the operation. In general, in large operations producing between 150 and 200 cubic metres per day the size of the crew will be between 8 and 10 men. In medium sized operations producing between 75 and 150 cubic metres per day the size of the crew will be 5 to 8 men and in operations producing up to 75 cubic metres per day the crew size will be between 3 and 5 men.

2. LABOUR FORCE REQUIRED IN THE INDUSTRY

In a 1974 report, Glen Murphy of the Forest Research Institute quoted a figure of 2796 people directly employed in the logging industry. Using this figure, the projected production rates to the year 2015 and accepting that the production rates per man year will remain reasonably constant, it is possible to predict approximately the numbers of employees required to service the logging industry over that period of time.

PERIOD	EXPECTED PRODUCTION (m/m^3)	EMPLOYEES REQUIRED	EMPLOYEES IN CABLE LOGGING
1974	9.293	2796	389
1976-80	9.471	2852	397
1981-85	9.582	2886	401
1986-90	9.566	2881	400
1991-95	12.715	3829	533
1996-00	17.718	5336	742
2001-05	24.473	7371	1025
2006-10	33.350	10045	1397
2011-15	36.140	10885	1415

It is apparent from the table that there will be no great build up in the numbers required to service cable logging operations. The use of cable logging systems will probably increase within this time period as the forests planted on more difficult terrain are utilised. This will mean that the employee figures given for cable logging will increase by about 5% in each year.

3. NEED FOR CABLE LOGGING

Much has been said of this apparent need to increase the useage of cable logging systems within exotic forests over the next twenty years. This opinion has been based on the assumption that many of the more recently planted areas are unsuited to any other form of extraction method. I do not completely agree with this assumption and I consider that cable logging systems should only be used, even in sensitive areas, after a very careful study of the possible alternative of tractor or the skidder systems has proved that these would be unsuitable. There is no doubt that any increased useage of cable logging systems will result in increased production cost and the indescriminate useage of cable systems in areas where they are not required must be avoided.

4. SKILLS REQUIRED

When looking at the type of additional skills that are required by people employed in cable logging it is necessary to consider how each of the basic functions of the logging operation differ between tractor or skidder and cable systems. The basic functions for any logging operation can be broken down into four parts and the skills required in each part can be compared for tractor/skidder and cable systems. By using a comparison it is possible to isolate the areas where additional skills are required by employees engaged on cable logging operations.

FELLING

Tractor/Skidder Logging:

The feller must have the skill to fell trees in a pattern to facilitate the extraction of the tree to the landing or processing area.

Cable Logging

The skills required in felling for a cable system are exactly the same as those required in a tractor or skidder operation. The only additional skill that is required of the faller is perhaps the ability and inclination to work on steep terrain.

BREAKING OUT

Tractor/Skidder Logging:

The breaker out must be able to select the correct logs to make up the drag and balance the drag size to match the capacity of the hauling unit.

Cable Systems

The breaker out must have the same skills in drag selection and balance as the man in the tractor/skidder operation but he also requires the additional skill of being able to shift haul lines to facilitate hauling.

SKID WORK

Tractor/Skidding Logging:

Those men employed on skid work require skill in the trimming and processing of the tree into log form.

Cable Systems

The skill required in cable systems are exactly the same as those required in a tractor/skidder operation.

Machine Operation

In this area I will look at only the extraction units as the other ancillary units in an operation such as loaders are incidental to the productivity of the operation.

Tractor/Skidder Logging

The operator on the extraction unit by his operating skill dictates to a large extent the productivity of the operation. His decision governs the haul route to be taken to the landing, the speed of travel and the load size to be carried. His skill in machine operation is directly reflected in the volumes produced each day.

Cable Systems

The operator on the extraction unit must have the skills necessary to set up his machine on the landing in the best position and the ability to change guy positioning as required to maintain his unit in the correct position. He must be able to maintain the haul lines in good order on the drums and be aware of the strains placed on the system by the load carried. The operator generally has very little say in how the haul lines are positioned for extraction.

From this comparison we can see that the only areas where additional skills are required are in breaking out and to a lessor extent, in machine operation. The other skills that are required in cable logging are exactly the same as those required in tractor or skidder logging.

If we look at the importance of breaking out and machine operation in cable systems in terms of productivity how much importance should be placed on each area.

In my opinion the additional skills required of the machine operator have very little influence on the productivity of the logging operation.

It is also my opinion that the additional skills required of the breaker out are vital to the productivity of any cable logging operation. Basically the additional skill that is required is the ability of the breaker out to shift the haul lines to facilitate hauling.

In tractor/skidding operations I said that the productivity of the operation hinged on the skill of the machine operator because he controlled the selection of the haul route and the speed of extraction. In cable logging these functions are controlled by the breaker out. The breaker out determines where the haul lines are placed and he can make or break a cable logging operation solely on his performance of this function. The operator on the extraction unit has practically no control over the extraction phase of the operation and is completely dependant on the judgement of the breaker out during extraction.

Whereas in a tractor/skidder operation productivity is controlled by the machine operator in cable systems crew productivity is controlled by the breaker out.

5. TRAINING

When we look at the type of training required for people working with cable systems we are basically looking at two different levels of training. The first level is management training and the second level is the training of employees working in particular facets of the cable system.

Management Training

Management training is the training of owners, supervisors and planners in the correct application and operation of cable systems.

If the expected build up in the numbers of cable systems used in New Zealand logging takes place many owners are going to be faced with the problem of operating cable systems without having had the opportunity to gain prior experience in their operation.

In cable logging a knowledge of the limitations of systems is essential if they are to be operated efficiently. This knowledge is particularly essential for those people engaged in the planning of logging areas. Their experience and skill in the selection of landing areas and the laying out of haul boundaries and road lines is crucial to the success of a cable logging operation.

Seminars such as this will help in making people and organisations considering cable logging systems aware of the problems that are involved but there is a very evident need however for more intensive training to be carried out. The only organisation currently carrying out training courses for people engaged in the logging industry is the New Zealand Forest Service through its Training Centre in Rotorua.

The courses run by the Forest Service cover broadly roading, setting, planning and supervisory techniques. The Forest Service would probably be willing to run courses covering more specialised areas of logging training but it would require more information from the industry on the type or course required and the participation of the industry in the running of the course.

Employee Training

In New Zealand the training of employees in the types of skills they require in a logging operation has largely been carried out on the job. The new man is placed with an experienced worker who assumes responsibility for his training. In large logging organisations attempts are made to train machine operators in the maintenance requirements for the machine they are to operate but the major emphasis has always been on the operator acquiring the necessary operating skills on the job.

On the whole this type of training has been reasonably successful and the industry is now served by a large work force of employees experienced in different types of logging operations. If we are to accept that there will be a large increase in the numbers of cable logging units used in New Zealand it is obvious however, that a different approach to training in this area will be needed.

It was previously mentioned that the major difference in the skills required in cable logging to the skills required in tractor or skidder logging were the skills of laying out haul lines and rigging. This is the area that controls the productivity of the operation and the area in which training is most urgently needed. I consider that this type of training can be carried out in a class room situation if required.

The basic knowledge required in this area is an appreciation of how topography affects the logging operation and an awareness of the rope layout requirements for particular cable systems. Because of the diversity of cable systems used in New Zealand this formal training must however be combined with practical training in the field.

Other training such as felling techniques for cable logging systems and machine operation can also be taught as combined classroom and field training sessions.

6. DEVELOPMENT OF TRAINING

Over the last two years several organisations in the Bay of Plenty region have been working together on the development of a training programme initially, for employees engaged in logging. This development has now progressed to the stage where approaches are being made to the industry by those organisations to investigate the setting up of a Logging Industry Training Board.

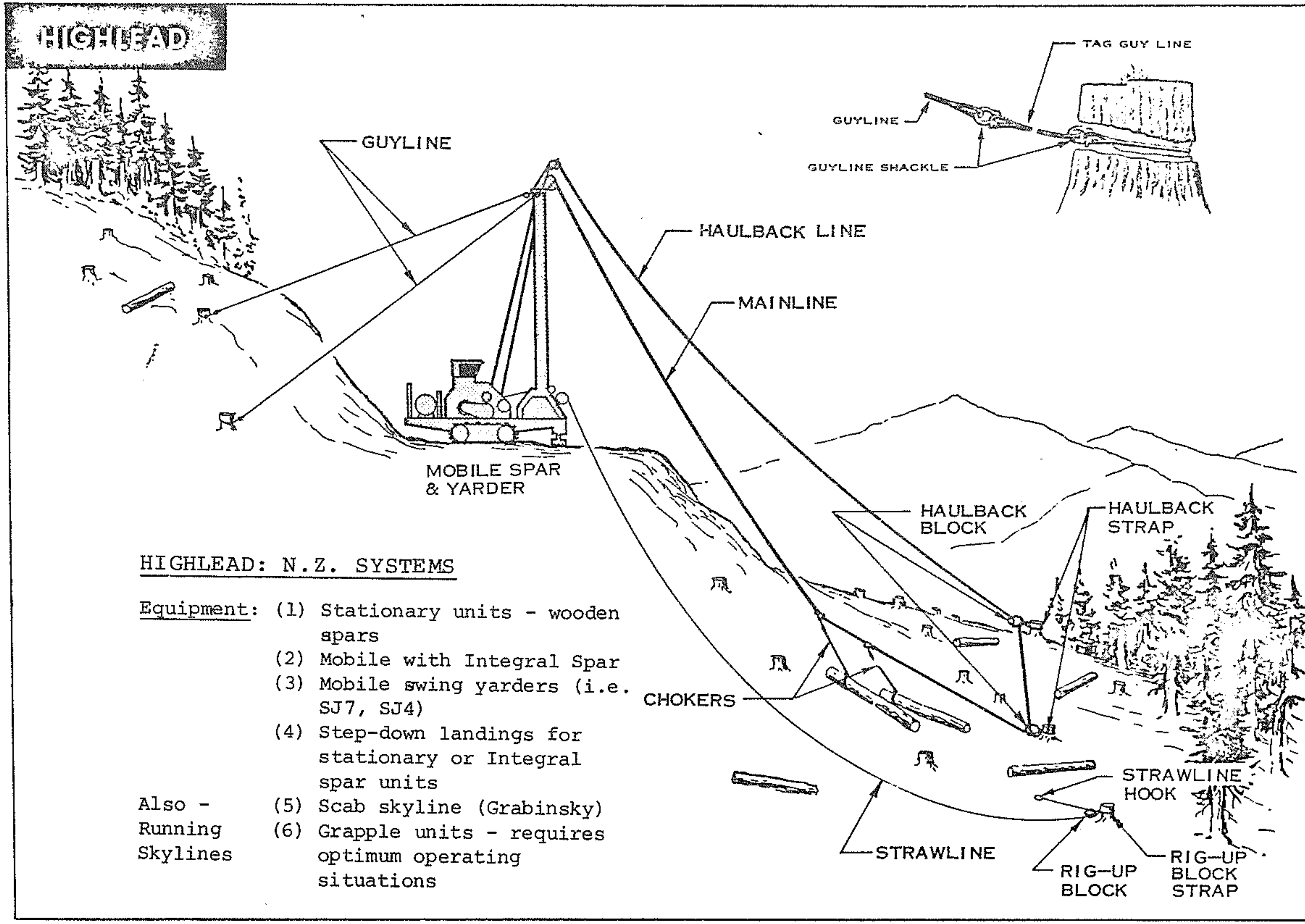
A Logging Industry Training Board if set up will provide many benefits in the field of logging training. A training board is funded through the Vocational Training Council who are responsible to Government for training in industry. They provide the finance to employ an executive training officer who is then responsible to the board for the investigation of the training requirement in the industry and for the setting up and running of courses specifically designed to meet industry requirements.

I consider that this Board if set up will provide great benefit in the field of training for the cable logging systems of the future.

APPENDIX I.

LET'S LOOK AT SYSTEMS

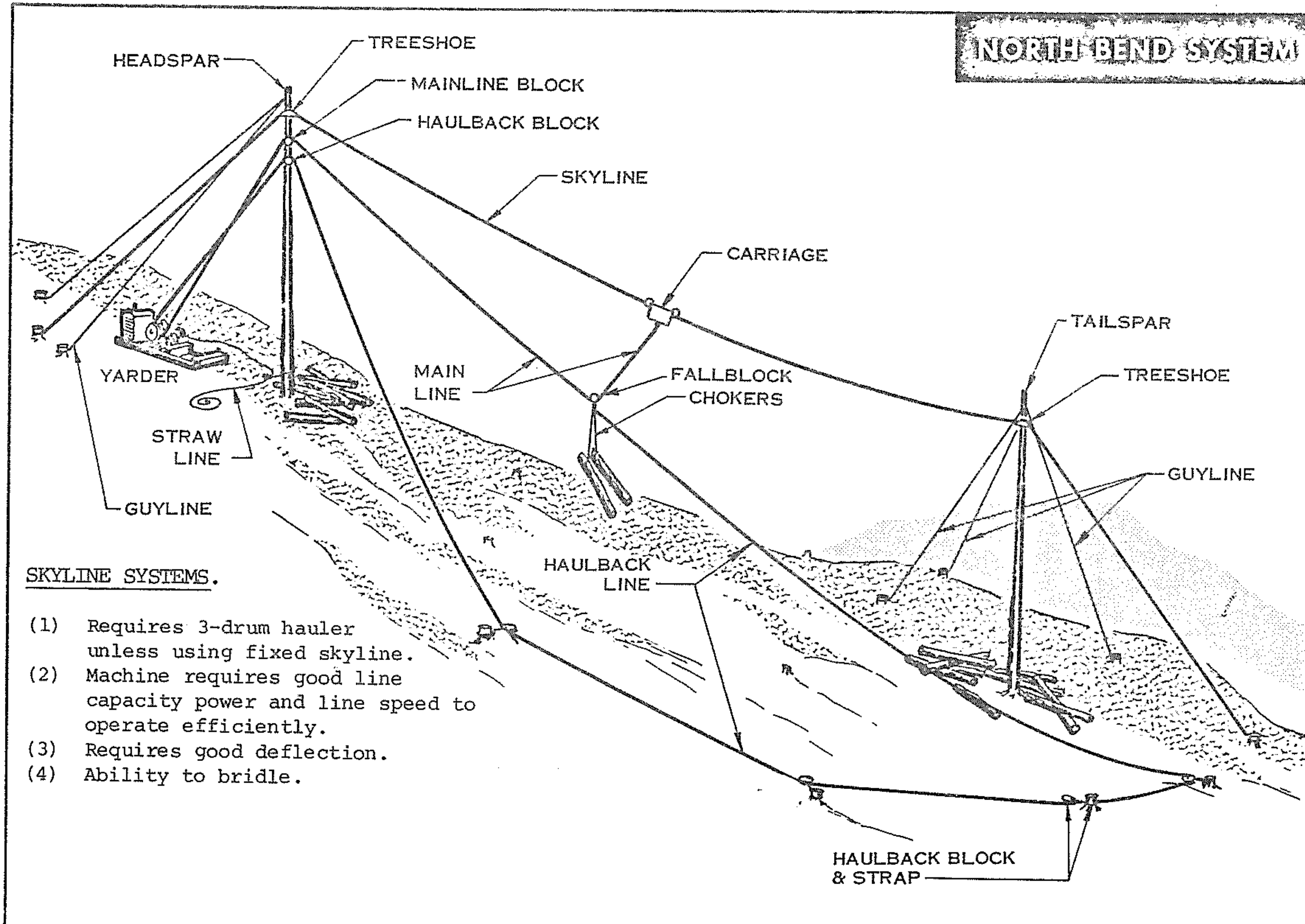
PART 1 - EXISTING N.Z. SYSTEMS.



HIGHLEAD: N.Z. SYSTEMS

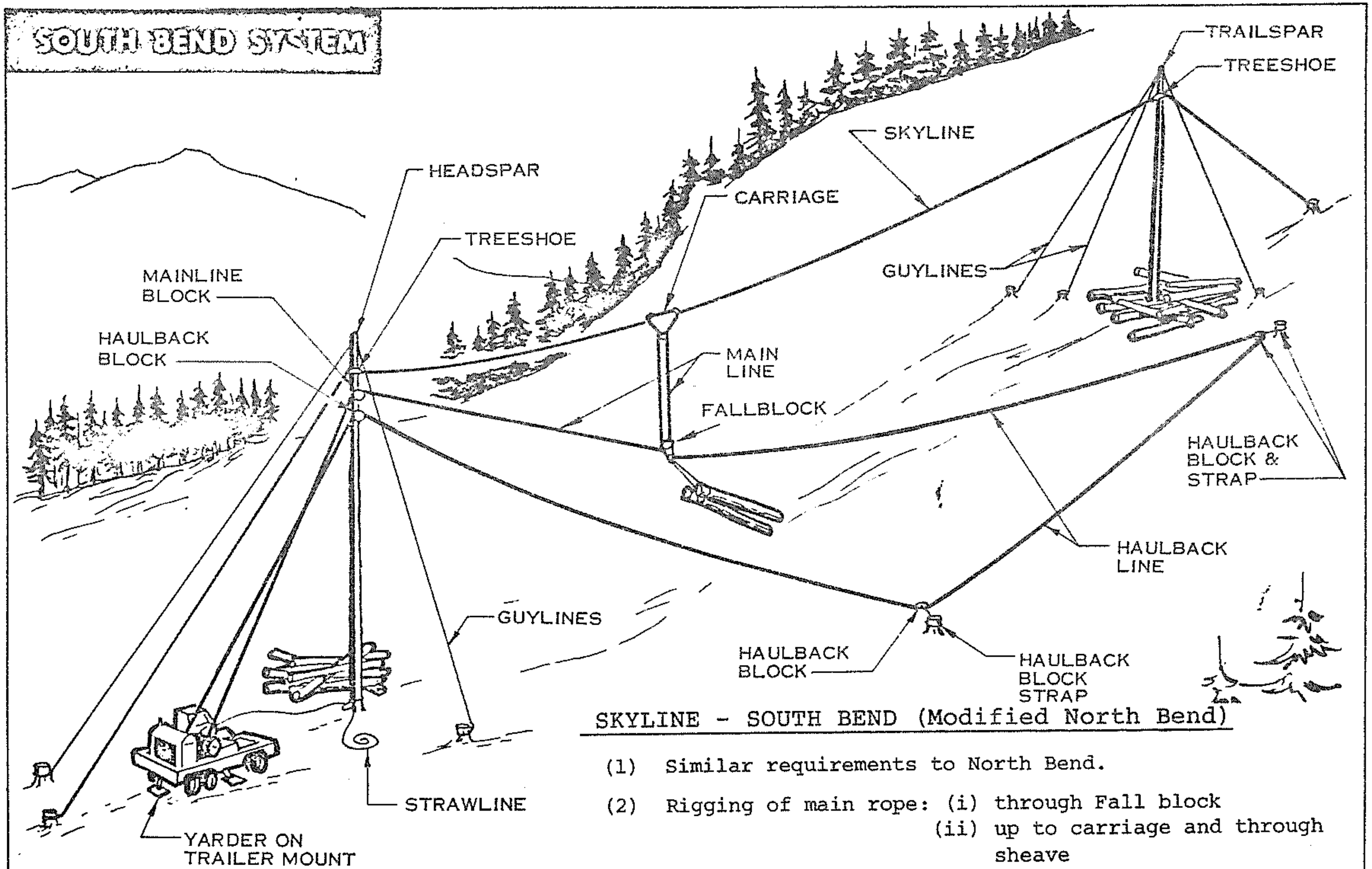
Equipment:
(1) Stationary units - wooden spars
(2) Mobile with Integral Spar
(3) Mobile swing yarders (i.e. SJ7, SJ4)
(4) Step-down landings for stationary or Integral spar units

Also - Running Skylines:
(5) Scab skyline (Grabinsky)
(6) Grapple units - requires optimum operating situations



SKYLINE SYSTEMS.

(1) Requires 3-drum hauler unless using fixed skyline.
(2) Machine requires good line capacity power and line speed to operate efficiently.
(3) Requires good deflection.
(4) Ability to bridle.



SKYLINE - SOUTH BEND (Modified North Bend)

(1) Similar requirements to North Bend.

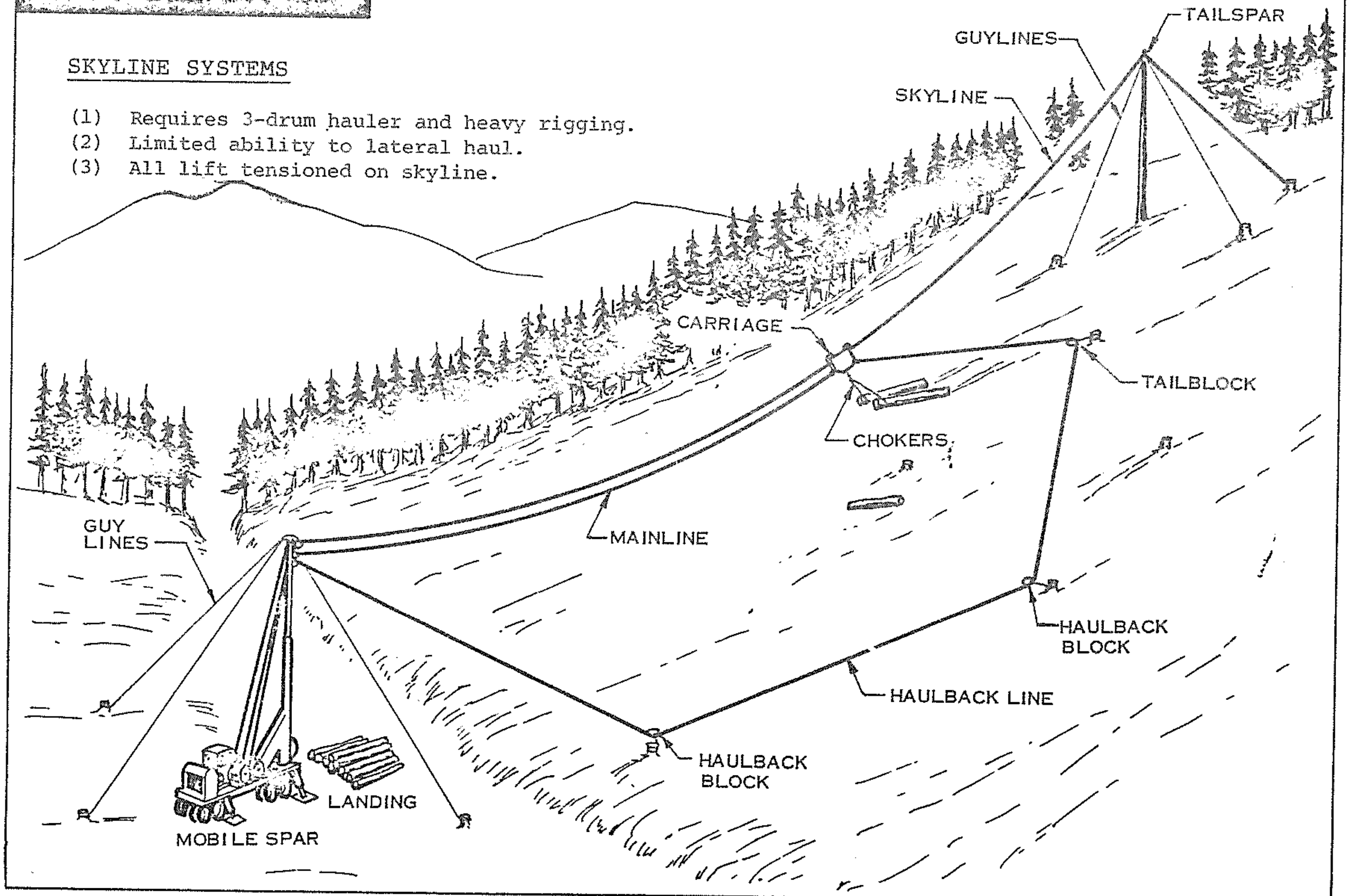
(2) Rigging of main rope: (i) through Fall block
(ii) up to carriage and through sheave
(iii) back down from carriage and fixed a fall block.

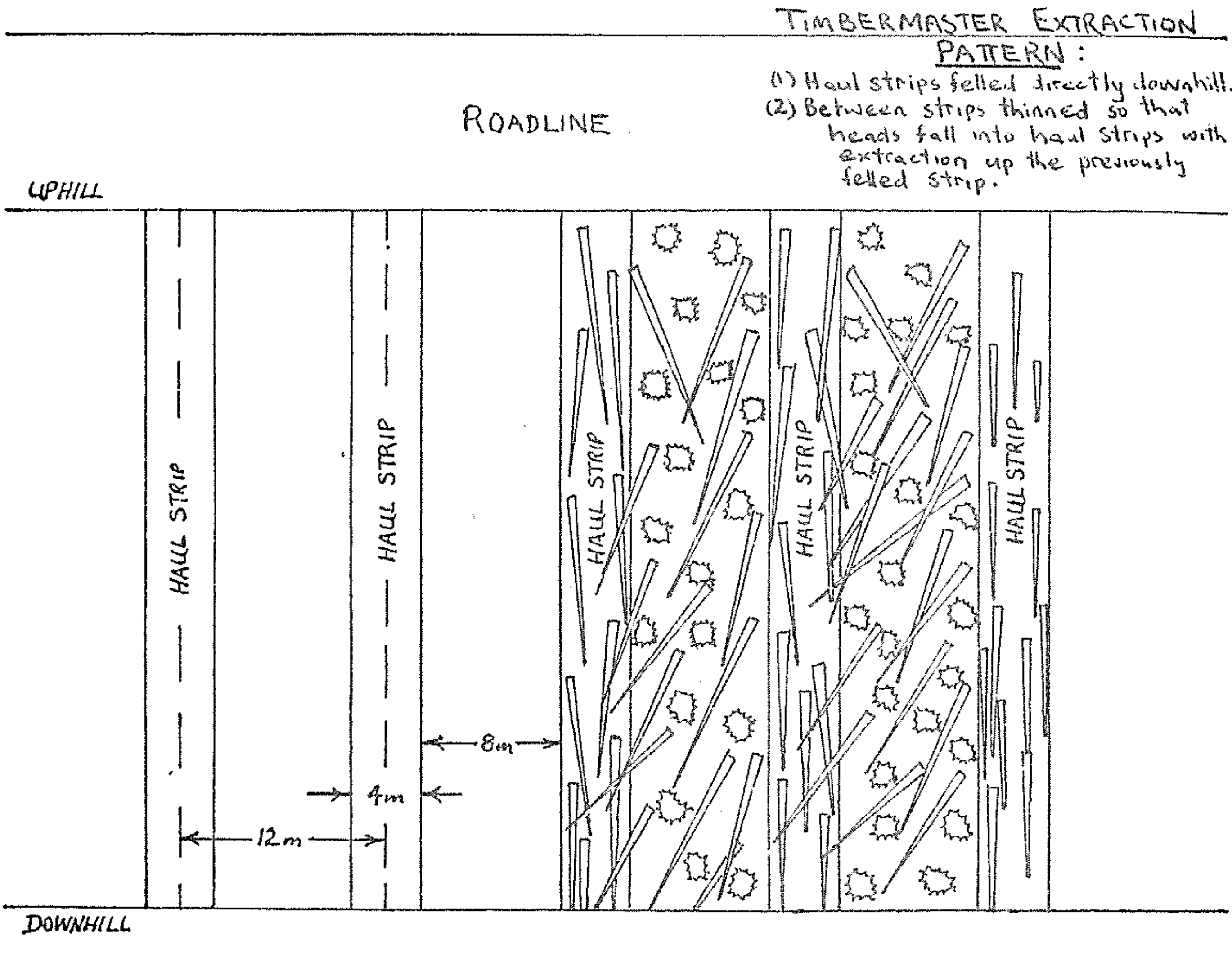
(3) More suited to downhill operating than North Bend.

SLACK LINE SYSTEM

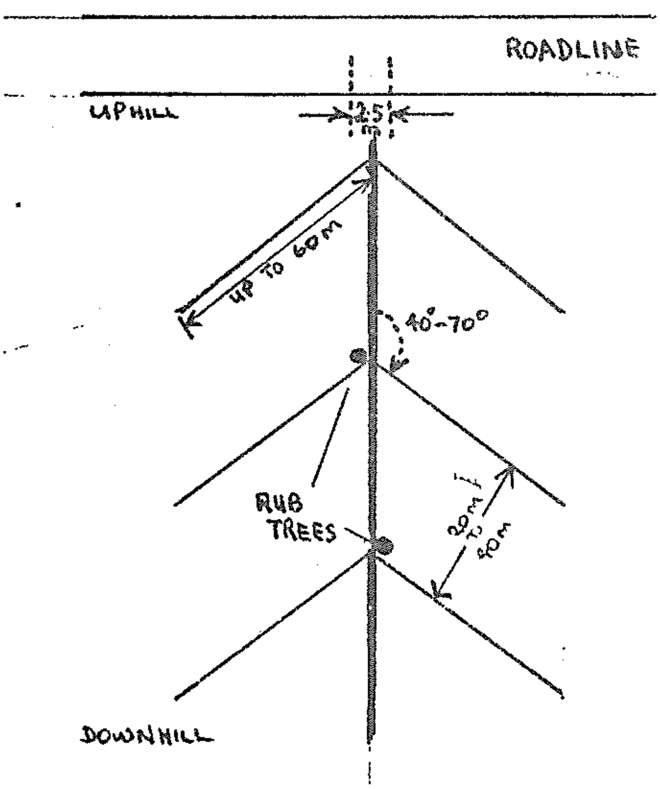
SKYLINE SYSTEMS

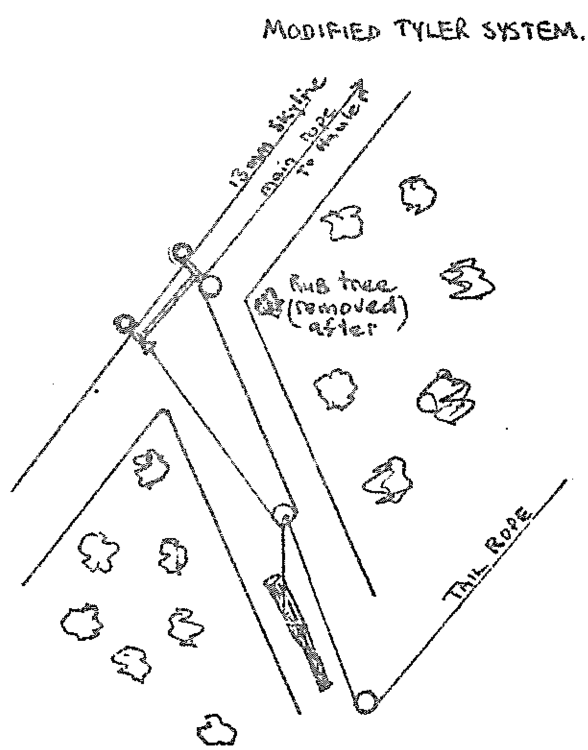
(1) Requires 3-drum hauler and heavy rigging.
(2) Limited ability to lateral haul.
(3) All lift tensioned on skyline.



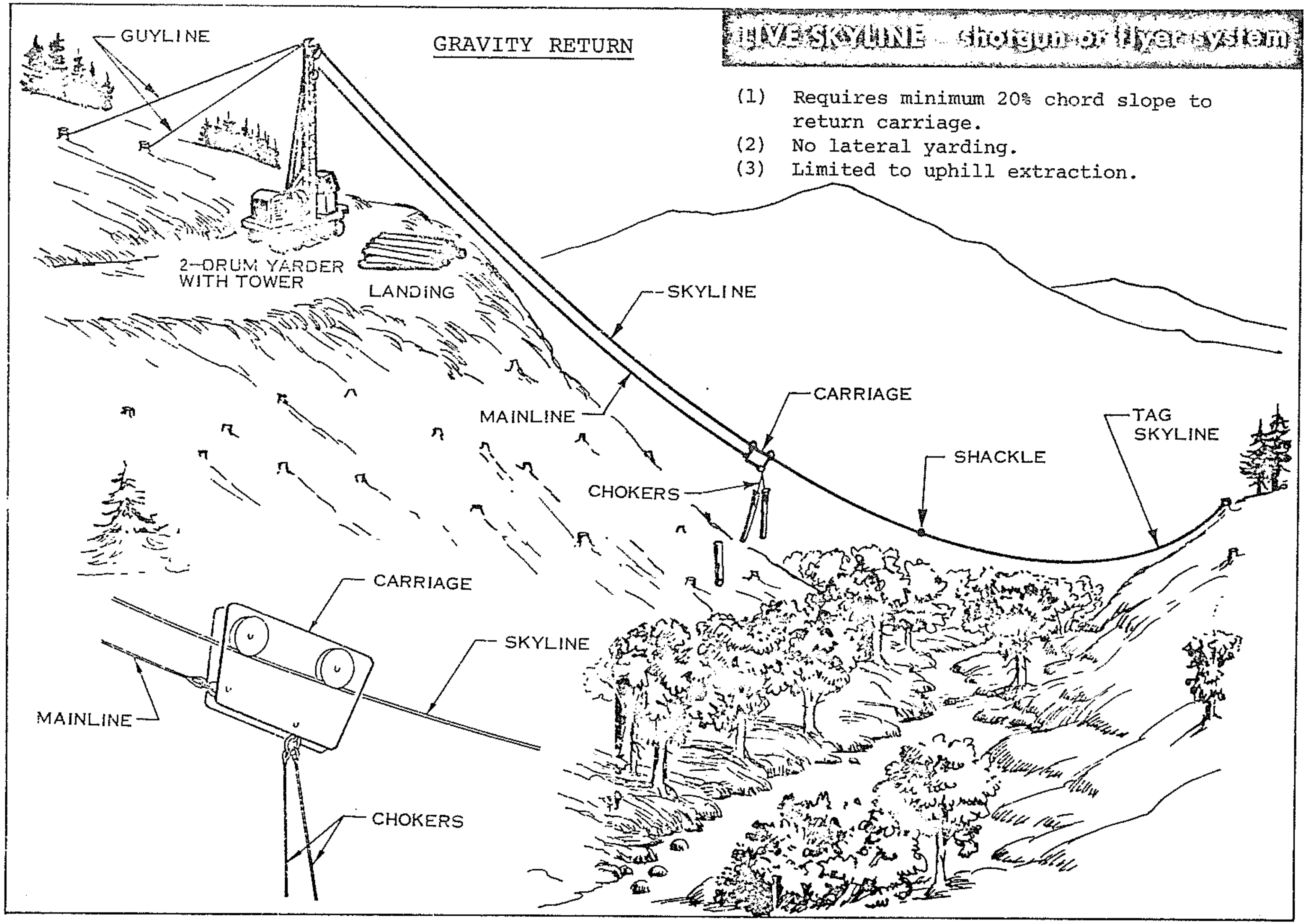


UPHILL THINNING - GOLDEN DOWNS EXPERIMENTAL

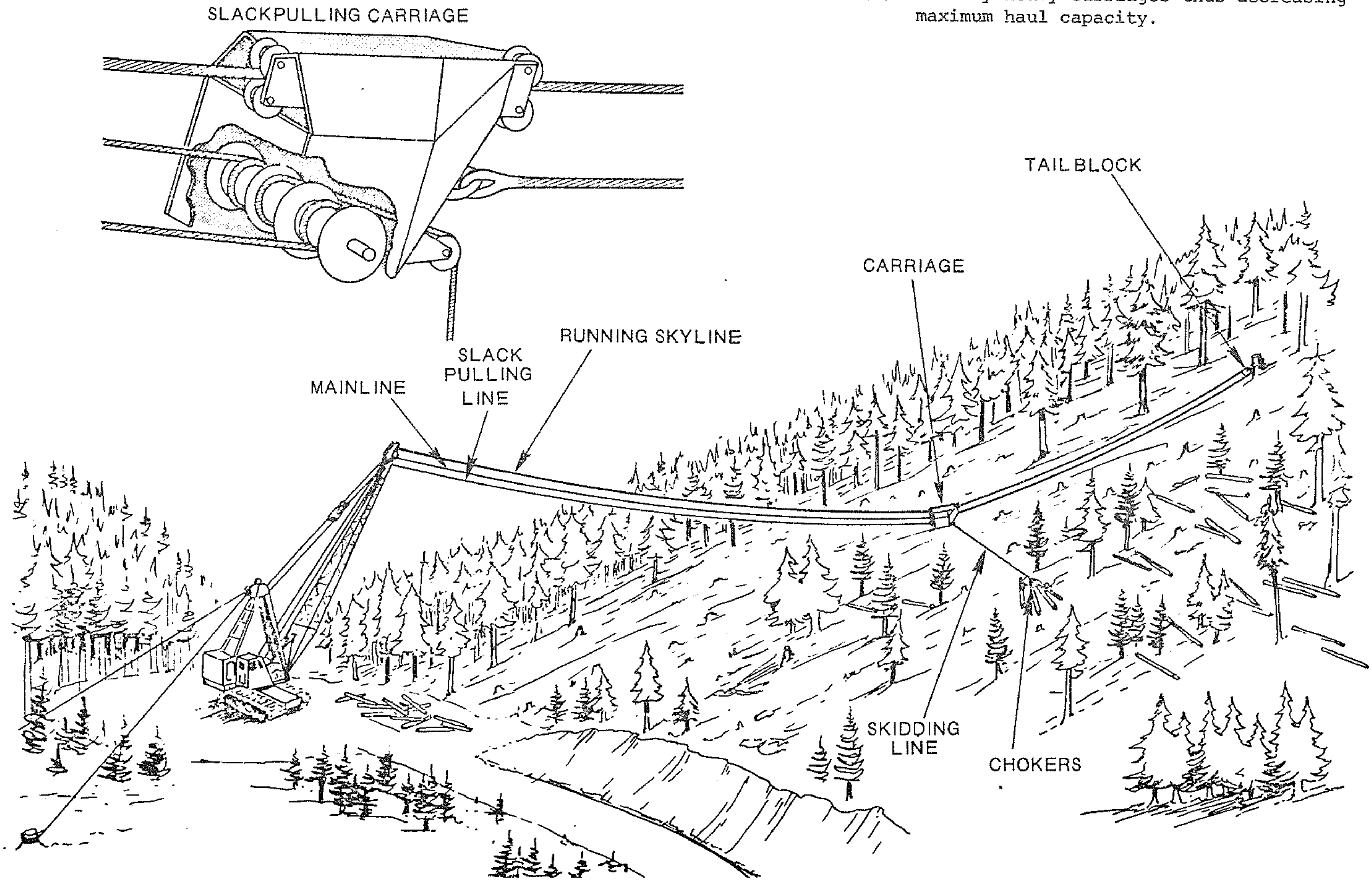




PART 2 - OVERSEAS SYSTEMS

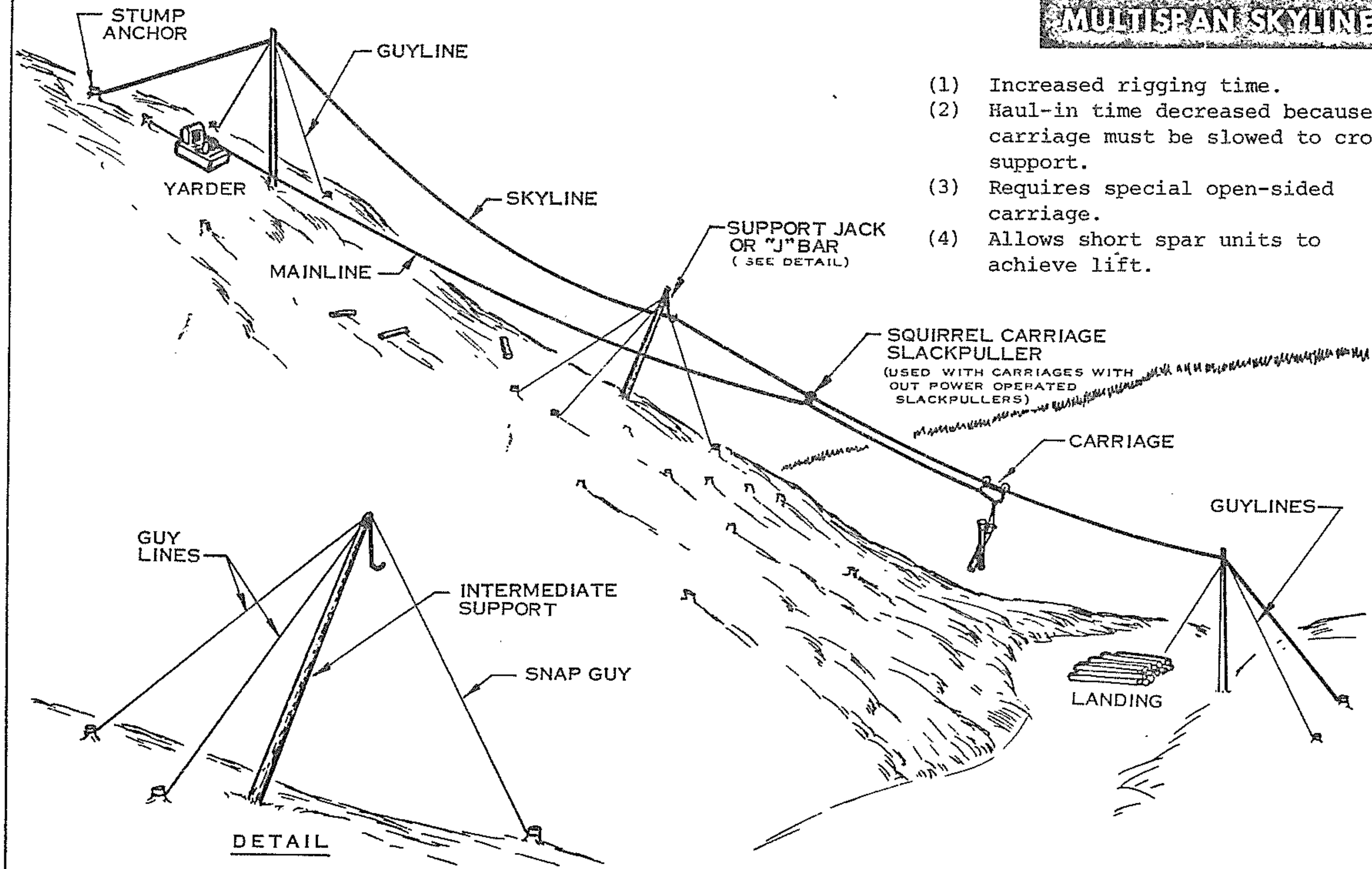

LIVE SKYLINE - shotgun or flyer system
(1) Requires minimum 20% chord slope to return carriage.
(2) No lateral yarding.
(3) Limited to uphill extraction.
GRAVITY RETURN
GUYLINE
2-DRUM YARDER WITH TOWER
LANDING
SKYLINE
MAINLINE
CARRIAGE
CHOKERS
SHACKLE
TAG SKYLINE
CARRIAGE
SKYLINE
MAINLINE
CHOKERS

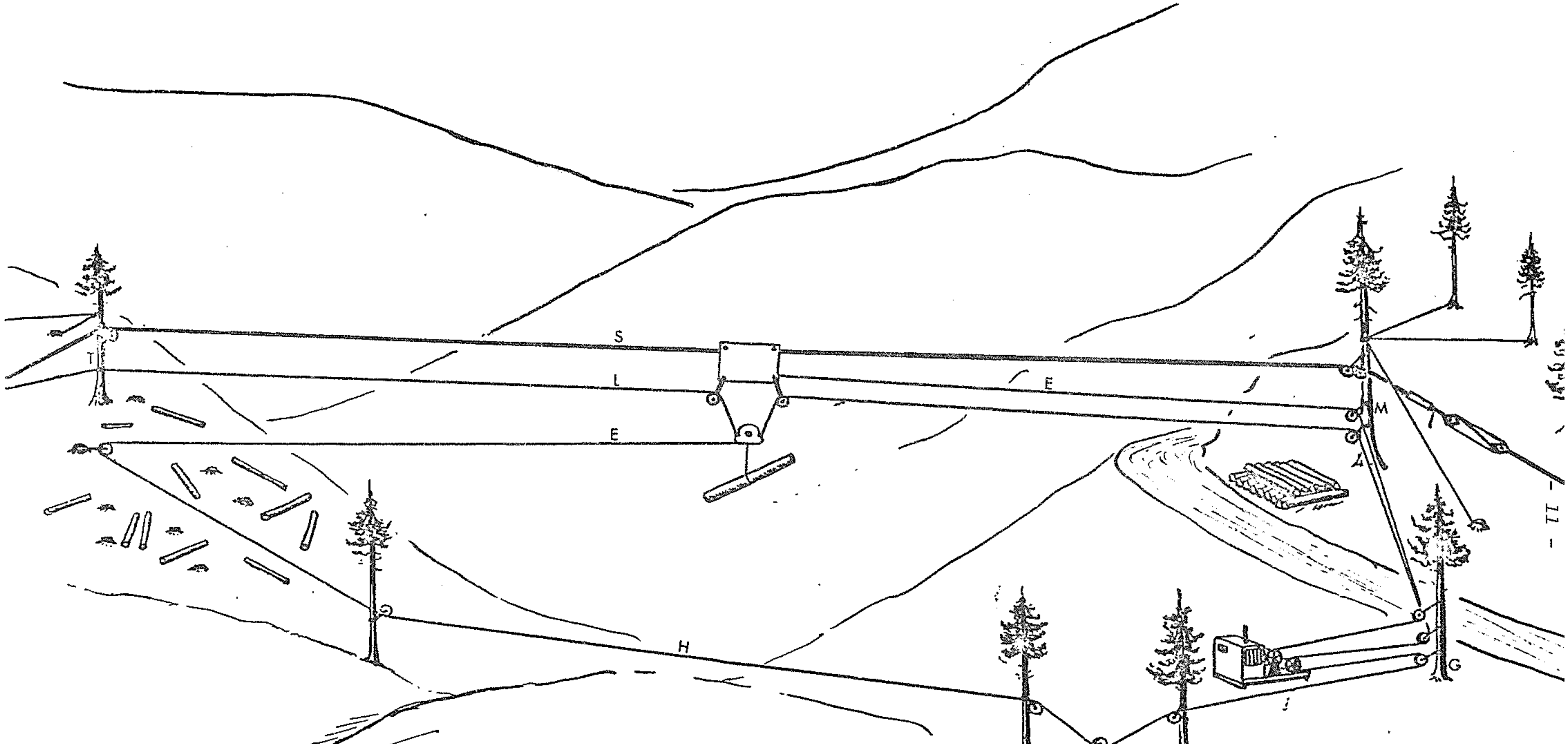
(1) Requires good deflection over total haul.
(2) Ideally suited to interlock yarders.
(3) Usually heavy carriages thus decreasing maximum haul capacity.



MULTISPAN SKYLINE

(1) Increased rigging time.
(2) Haul-in time decreased because carriage must be slowed to cross support.
(3) Requires special open-sided carriage.
(4) Allows short spar units to achieve lift.





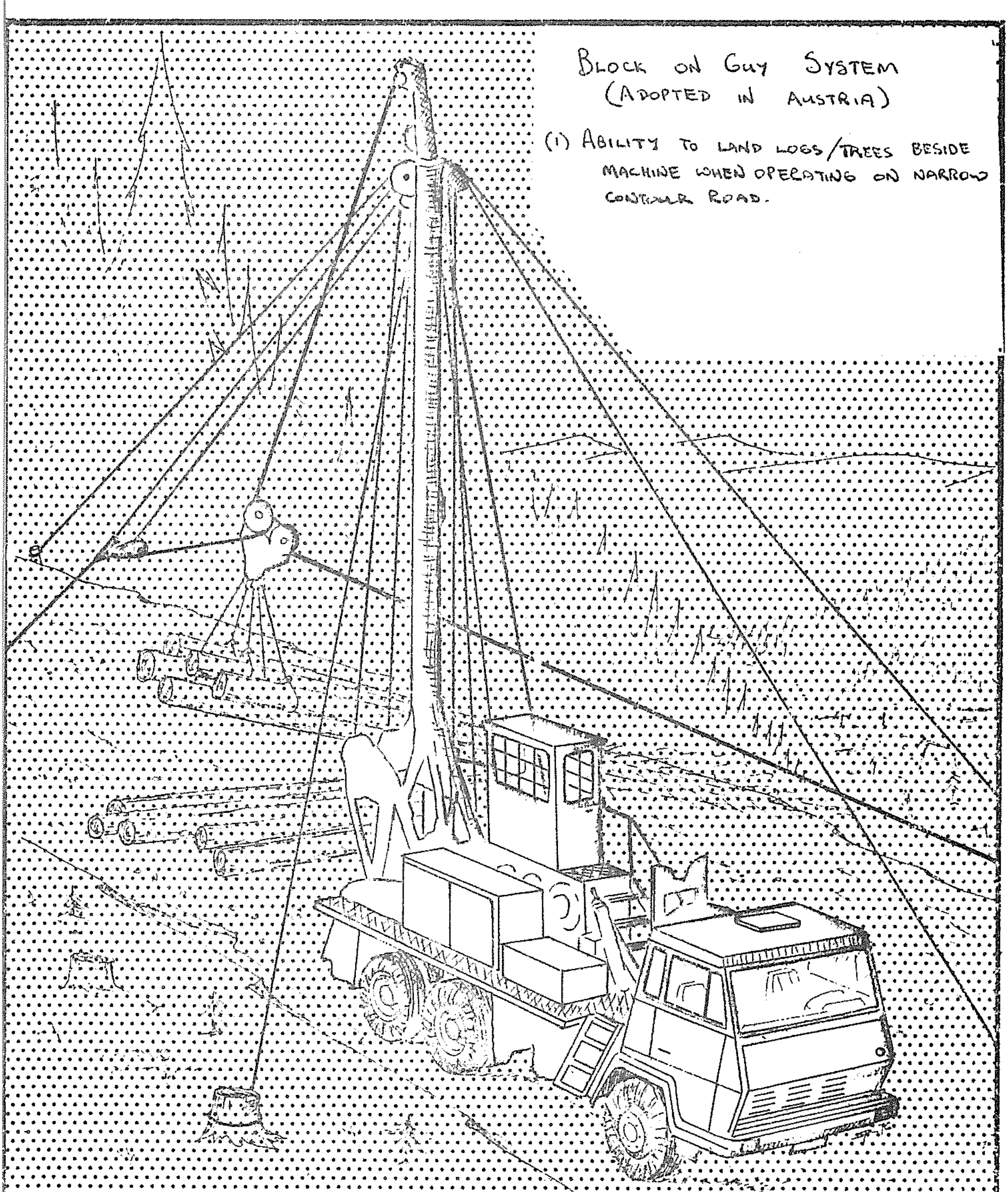
(1) Requires hauler with endless drum and two conventional drums if bridling is done.

(2) with fixed skyline - rigging delays occur.

(3) Increased rope wear as ropes are in constant motion.

ENDLESS TYLER SYSTEM OF RIGGING

S	SKYLINE
L	LIFTING LINE
E	ENDLESS LINE
H	HAULBACK
T	TAILTREE
M	MAIN SPAR
G	GUIDE TREE


BLOCK ON GUY SYSTEM
(ADOPTED IN AUSTRIA)
(1) ABILITY TO LAND LOGS/TREES BESIDE MACHINE WHEN OPERATING ON NARROW CONTOUR ROAD.