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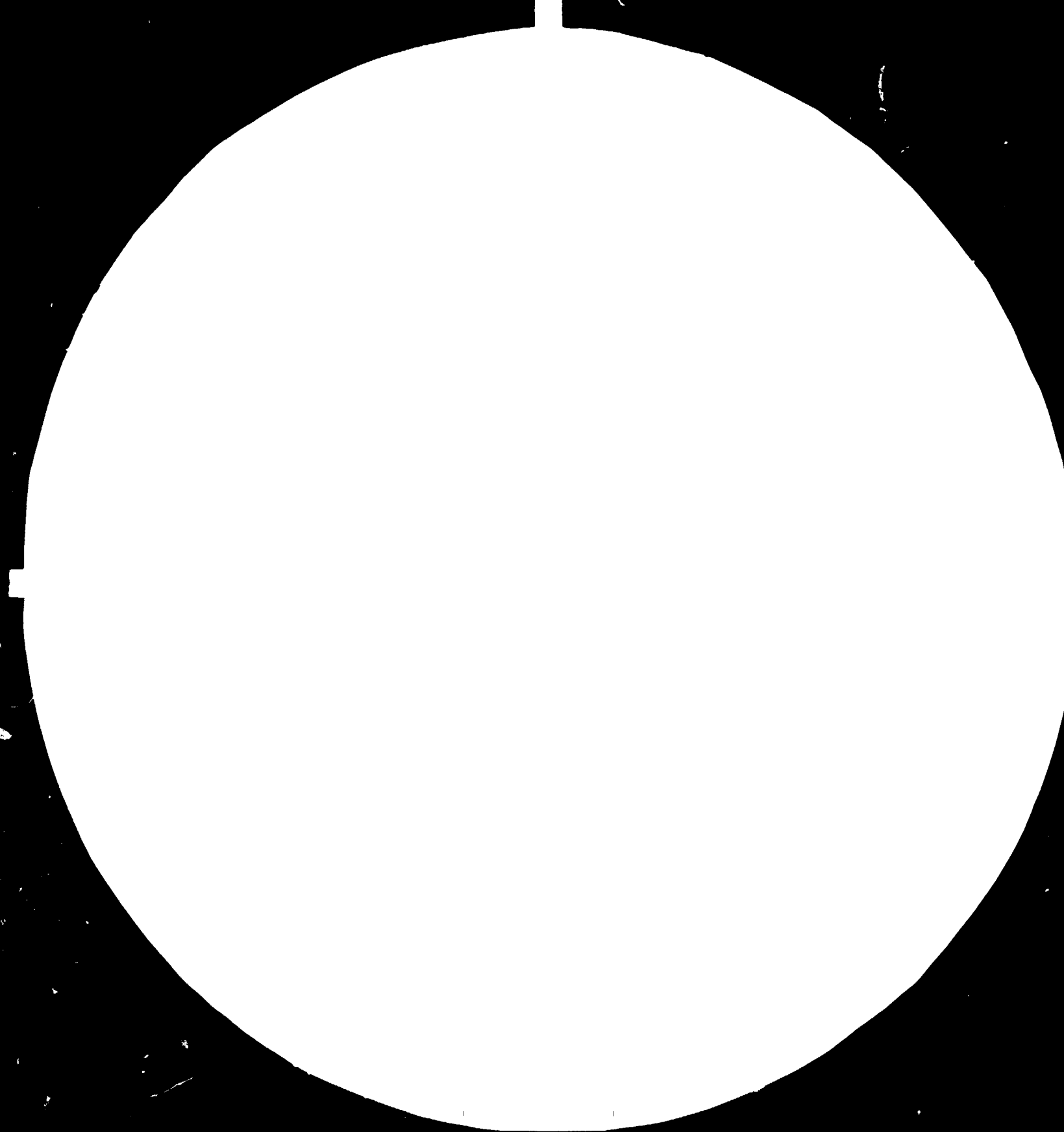

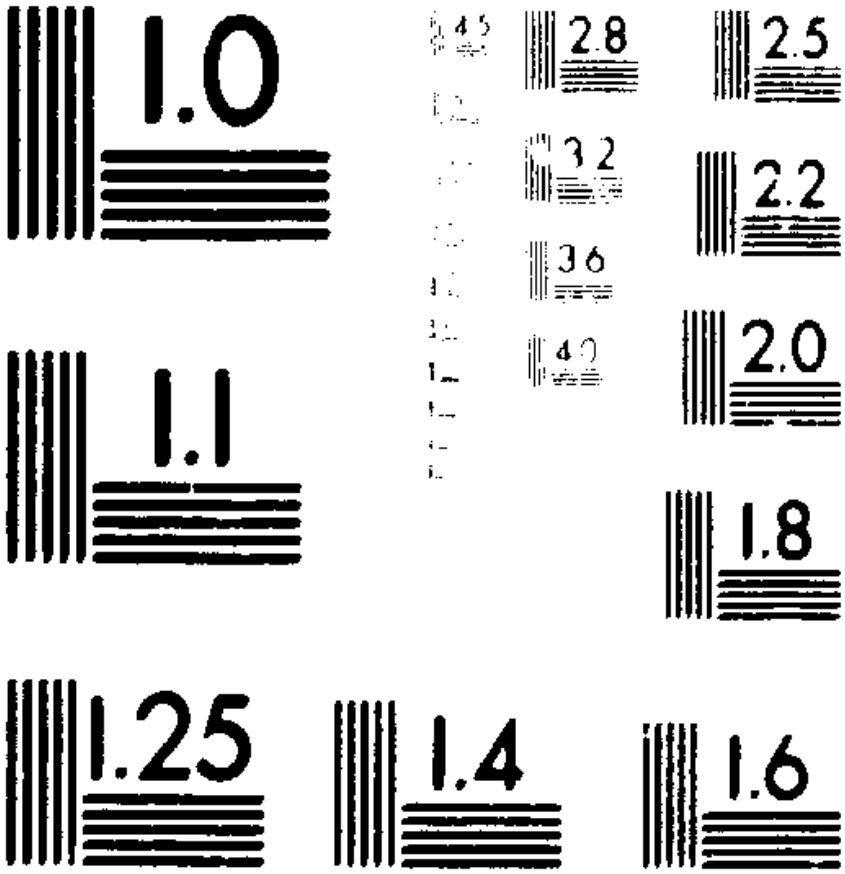

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Bjorn Eidsvig:

SELECTION OF APPROPRIATE TECHNOLOGY. A WORKING GUIDE.

5342

Report No. 69.
December 1984.

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Selection of Appropriate Technology. A working guide.

It has been realized that selection of in-appropriate technologies within the small scale industry in Indonesia is a reason for limitation in growth and development. That applies both to planning of new industry as well as to renewals and expansions within the existing Industry.

We have therefore promised to make some guidelines for the methodology of selecting appropriate technology and production machinery.

The guidelines are laid down in this report. The report contains the necessary explainations and a working from (appendix 1).
It also contains a check list, an excersise, and a solution to the excersise. The working form should be duplicated and made available for the various officers for practical use during evaluation and selection of technology, machinery, and other investment objects.

The methodology may be introduced tnrough this report to officers in charge of selecting, and advice on selection of investment alternatives. The report may also be used within various training programmes.

Sincerely yours

UNIDO INS 78/078,

Bjorn Eidsvig,
Industrial Engineer.

SELECTION OF APPROPRIATE TECHNOLOGY.
A WORKING GUIDE.

CONTENT

SELECTION OF TECHNOLOGY FOR INDUSTRIAL PROJECTS. A WORKING GUIDE.

In all industry in the world one is faced with the task of selecting technology for the production. One must select the type of process to be used for the different operations. One must also select the particular equipment that is fit for the production and the situation of the industry.

What one select must fit when it comes to the type of operations the equipment can do, and it must also be suitable concering capacities, capabilities, quality of the equipment, the need for operators, servicing, space, power, and other consumptions. It must further fit when it comes to the consumption and handling of materials, the quality of the operations and of the manufactured product.

It must fit when it comes to the need for flexibility, and to the requirements of the future. First of all however it must be economical, creating the lowest possible operational costs for the company.

All these considerations and factors are valid everywhere, but they have very different weight and importance from country to country, and also from the one factory to the other. That means that what is the best selection in one case, may be the very poorest choise in another.
Selection of technology and equipment must always be a individual consideration for the particular industry and the particular situation.

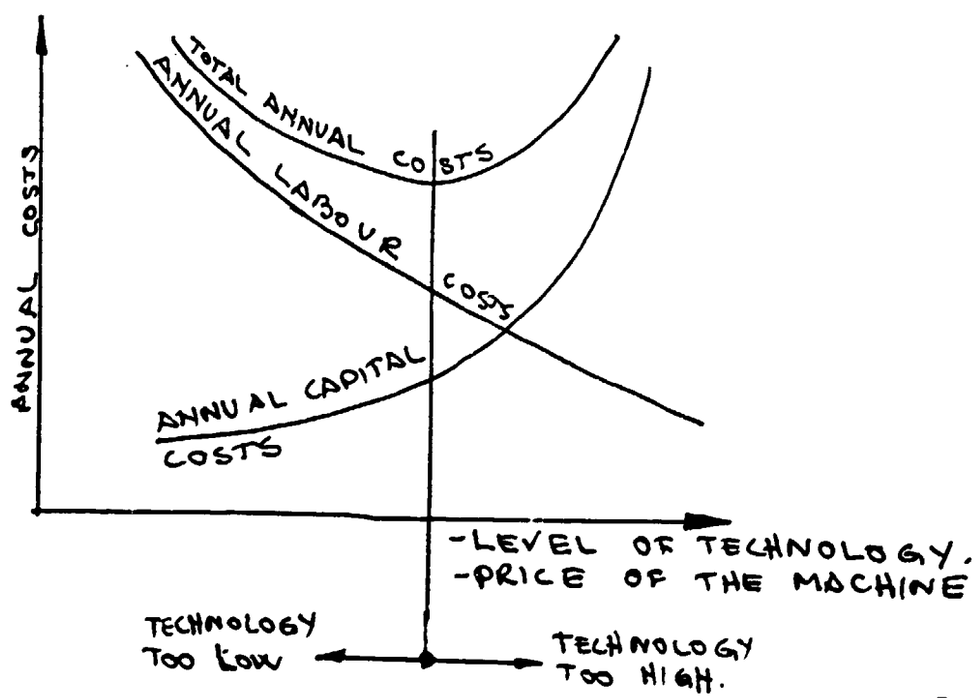
In Europe where labour is expensive and scarcely available, one may spend 100 mill. Rp. to save one operator.

In Indonesia it may not even pay to invest 5 mill Rp. for the same purpose, and one will be happy to offer employment opportunities. Hence also equipment made in other parts of the world for different economical situations, will generally not represent and optimal selection in Indonesia.

Selection of unsuitable equipment will always have negative economical consequences for the company. In serious cases, in competition with others doing better choises, it can very well be fatal for the company.

Whether one select equipment that is too advanced and expensive, or one select equipment that is cheap but require too much labour, the consequences will be the same; the annual cost of the company will be too high. One must for the selection calculate the yearly costs for the different alternatives that may be consisted.

One can not really plot in the different machines and equipment along a scale for price, and manpower need. The individual variations and other factors vary too much for that. In the principle however, one may draw a picture as follows; indicating that one in a particular situation can talk about an optimum level of technology:



Selection of technology is as long as one can judge cost and capacities, not any difficult task. Still however it is seen everywhere in the world that very ineconomical equipment is being selected.
The reason for this is first of all that one does not practise to calculate the economical consequences of the selections. In stead, one act on feelings and believes, listen to the arguments of the salesmen, etc.

The aim of this report is it therefore to introduce a simple way of optimising the selection of technology through economical comparison of available alternatives.

For planning of new industries and for major investment, doing right selection is of paramount importance. The amount of work that is required for doing comparison of alternatives is really nothing compared with the economical consequences of doing unsuitable selections.

One can of course always do the calculations more or less thorough. The more doubtful the situation, and the more major the matter, the more thoroughly should the situation be looked into. The job of doing the comparison itself is usually quickly done. More time consuming can it be to collect precise data for the different parameters of the calculations.

A rough calculation based on estimated factors is however always much better than doing no comparison at all.
When doing rough comparison one will normally see which factors are major and determining for the results, and one can after first doing rough calculations always go back and cross check the more important data.

The simplest way of comparison is to calculate the annual cost for each alternative, separating fixed from variable costs.

The fixed costs include first of all depreciation and interest of the machinery and the invested capital. But it may also include rent for the occupied space, increased fixed costs for electricity, extra employed administration, maintenance on fixed contract basis, etc.

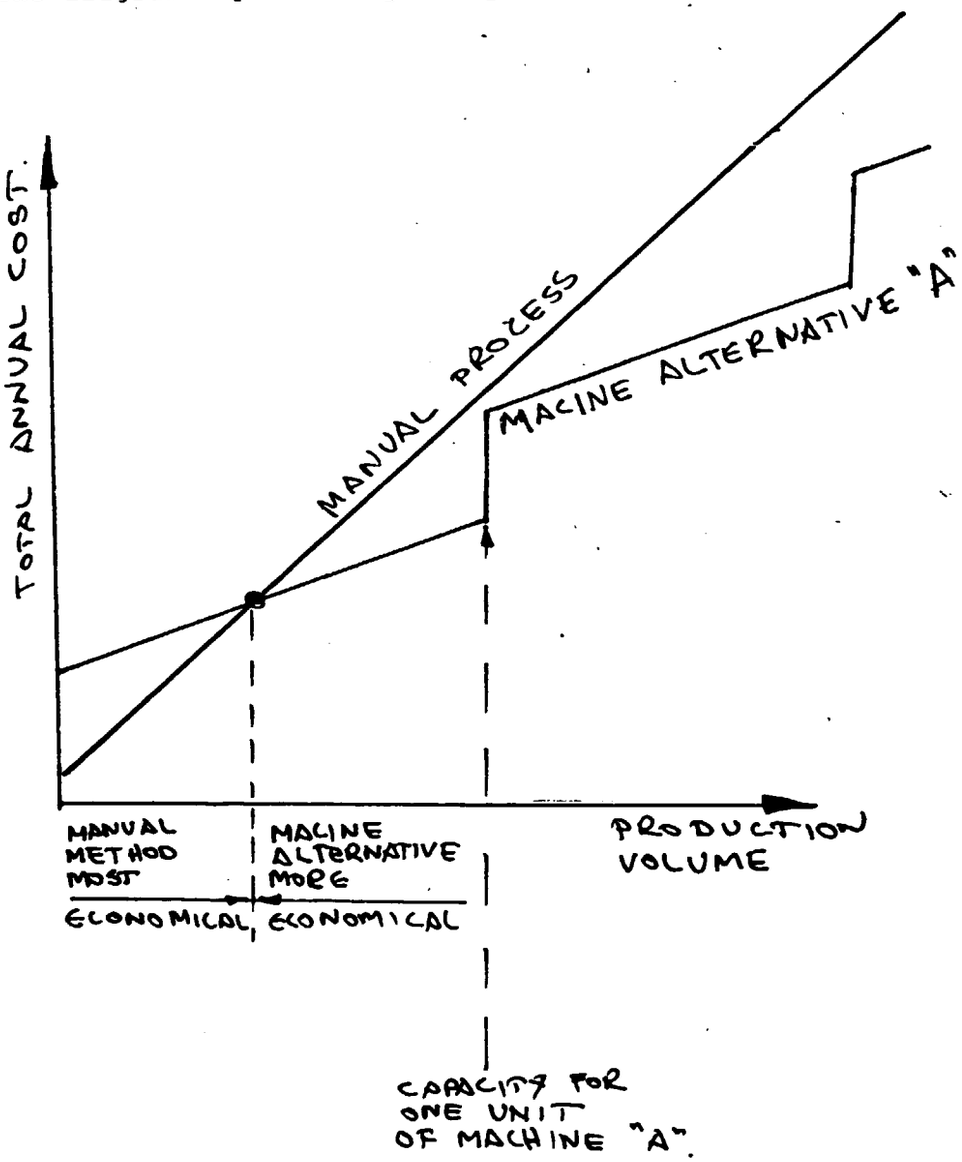
The variable costs involve general labour, material costs, consumption of electricity, fuel, compressed air, general maintenance and repair, etc.

One may to simplify the calculations, exclude all factors that will remain equal for all alternatives to be compared.

One will most often also find that the alternatives to be compared do not have equal capacities, whereas the comparison must be done for equal sizes of production.
Alternatives having lower capacity than what is required may also very well be used, and will often be the most economical, but duplication of the equipment with 2 or more parallel installations will than be required. When the required capacity is uncertain, such alternatives will often be more econimical, since one can start with one or fewer installations and duplicate with additional equipment as the requirement increase in the practise.

The considerations and selection will in these cases be much clearer when one draw a cost diagram showing how the annual costs vary with the production volume.

The diagram may in the principle look e.g. as follows:



In some cases, especially when the plant for a start is not fully utilized, when other factors may also change from year to year, when the plant may be built out in stages and when the machine has a considerable final salvation value, it may not give a clear picture to calculate and compare annual costs, because the situation change from year to year. In such cases one can instead calculate the internal rate of return based e.g. on the initial 10 years of operation.

THE STEPS OF THE SELECTION PROCESS.

The sequence of selecting alternative may rationally be the following:

1. Clarify the processing requirements
2. Get to know the unlike technologies that may be used for the purpose.
3. Compare technologies
4. Choose the appropriate technology
5. Collect machine quotations for the selected technology.
6. Get to know the quoted machines.
7. Do costs comparison between the machine alternatives.
8. Select the best alternative.
9. Check the selection and improve.

On the steps of the selection you may consider the following:

1. Clarify the requirements.

First of all make sure that you know what is actually required, in terms of production volume, required dimensions and varieties, quality, material processing ability and possible other factors.

If the machine is to fit into an existing plant with an existing capacity and production, it may be farily easy to determine the volume requirements.

For a new plant where the production is dependant on an estimated market demand, one can not so easily determine a definete requirement volume, and may estimate an optimistic and a pessimistic volume rather than a definite figure. That is quite acceptable for the comparison. If the machine must be capable of certain dimensions and varieties in the processing, the equipment must of course be able to comply with that in one way or another. If not, it will simply not be any subject for comparison. Those needs may however not always be exact, and it may sometimes be more a question about a wish than a need. Comparing machines with different capability accordingly, may hence be reflected in the sales programme and the generated total sales value.

The same considerations may apply when it comes to the requirement for work quality.

A machine must be able also to process the available raw materials in the conditions they have.
If not, one may sometimes be able to use additional preprocessing equipment or purchase preprossed materials, something that must be reflected in the calculations.

2. Get to know the unlike technologies.

Do not take it for granted that you really know all the different ways of doing the processing. Many methods exist for most processes, manual methods, machine methods, automatic processing, processes based on different raw materials, processing giving different variations of the product.

You need to get a good clue about costings, consumptions, capacities and product qualities for the different methods.
It is better first to compare the different methods and find out which system appears to be the best. Later on will the question about collecting quotations for different brands and models of machines arise, but firstly be concrered about the choise of the system or principle in general.

Talk co people in the trade and in the industry and see what others have installed. Study the litterature and available quotations and find answers to the different questions that arise.

3. Compare technologies.

Comparison between the different possible alternatives can in general best be done on an economical basis. Use the form in appendix 1 for the comparison.

You may compare as many alternatives as possibly may turn out to be the best choise. There are 3 alternative rubrics in the form, but you may extend a further sheet of rubrics when required.

The system is based on comparing annual costs of the different alternatives, to see which alternative brings the lowest cost for the required production volume when working products of an equal standard based on the requirements of the market.

As long as the aim in only to compare the alternatives and not to judge the viability of the project or to calculate the manufacturing costs, one may concentrate the comparison to only those factors where any of the alternatives differ from others.

If one of the machines will consume more or less raw materials than others, than the material costs must be included in the comparison; otherwise not.

The same will be the question if there are difference between the alternatives when it comes to manpower, electricity, space demand, maintenance or product quality that may affect the price, the sales efforts, or the sales volume.

It may happen that there at times will be differences in factors that are not included in the form. That may involve e.g. differences in insurance rates, general management costs, etc. Please make sure that such differences will be included in the comparison, being expressed as differences in the annual fixed or variable costs.

It is normally required to do some basic calculations so as to arrive at the annual costs for the different matters. Some of these calculations have been provided for in the form.

Machine capacity: Be sure that you calculate with the net practical capacity that will be obtained on an annual basis, having deducted for limitation in speed utilization, and for stops in the production for technical, personal or administrative reasons. Also you must do necessary deduction in the expectancies necause of wreck production, reworking, maintenance, control, etc.
In the form this has been expressed as a gross machine capacity to be multiplied with a series of factors to arrive at a net practical obtainable production capacity.

Example: Gross capacity 1.000 items/hour.
240 working hours per year.
90 % speed utilization,
25 % stop for control, maintenance, adjustments, power cut, etc.
20 % stop for delayed orders, supplies, take off, lack of precense, etc.
3 % wreck
15 % reworking
30 % off-season stop in the production.

= 1.000 x 240 x 0.9 x 0.75 x 0.8 x 0.97 x 0.85 x 0. 7

= 667.000 items/year.

Expected Sales:

The machine capacity may be very different from alternative to alternative, independantly of what one actually expect to sell and manufacture. It is the sales and the practical use of the machine that matters, not capacity that is not being used. One must of course have enough machine capacity to cope with the production, being it one or more machines.

A machine that has a higher capacity than what is required for the production will be in operation for a shorter time. That affects some of the variable costs, especially the operations will not be required on full time. Calculate the operation time.

If an expensive machine has too low capacity for the sales, it may often be better to work on shift than to duplicate the machine, (something that again may be held up against each other as alternatives for comparison).

Product price: When the different processes make equal quality products, the question about product price will not arise. It will automatically be equal and the sales value does not need to be calculated.
When the product quality will not be equal, that may have different consequences;

a) the quality is not good enough, and the process can not be used unless being improved.

b) the quality is acceptable and can be compensated in the product price, expecting the same sales volume

c) the price should be kept the same and an adjustable sales volume can be accepted.

d) the price and sales volume expected to be the same, but the other costs will change, for the further processing or for the sales costs.

One of these changes must be expected and they must be compensated for in the calculations.

Further differing factors: As listed in the form, the differing factors should be specified.
The rate of depreciation is frequently considered to be 10 years (10 %). The depreciation time may however be shorter or longer dependant on the solidity of equipment, the rate of use, and the chanse of equipment becoming obsolete. That may vary from a alternative to alternative.

The rate of interest may be considered as the cost if borrowing the capital for the investment. It may however also be correct to calculate with an internal rate of return, the capital gain that develops through the normal business operations.
If the different a alternatives should be differently financed, different rates of interest may occur.

The floor space that is required for the total processing may be different for different alternatives and a different houserent may hence occur, whether rented space or own building. Look at the whole process, not only the space needed for the machine itself.

The need for manpower may also differ from process to process, and it may possibly involve also others than the machine operators.

The cost of wastes may at times be quite different from the one process alternative to the other. The major cost use to be materials being spoilt, but also other processing costs occur. It is important to judge this factor very carefully for the differences between the alternatives.

Investments: The investments will not primarily be compared directly, but mainly serve as a basis to calculate interests and depreciations. However, when capital is a limiting factor, and when financing is difficult, one may be forced to select less economical but less investment demanding alternative.

All costs required for purchase, installation, process training, including what ever is required of equipment to make the process operational, must be included in the total alternative investment.

Fixed annual Costs: The fixed costs include all annual costs that occur to make the production operational and that in general will not wary much whether the production is high or low. That involves depreciations, interest on the investments, space rent, and works supervision.

It is important to know the ammount of fixed costs separate from the variable costs. The fixed costs are so much more serious since they continue to occur whether the production is high or low.

If the production and the production quantity is not very very certain, it is often better to accept higher total costs, provided the share of fixed costs is lower. The fixed costs always involve much larger risks.
Specify the fixed costs based on investments and other factors mentioned above.

Variable Costs. Add together all the variable costs as well, first of all including labour costs, maintenance, material costs, waste costs, electricity and other consumptions. Add together the sum of variable and fixed costs and [illegible] have in most cases a background for comparison.

Profit comparison. Only if the sales values will be different from alternative to alternative, the profit must be calculated. The profit is the difference between the net ex production sales value and the total costs.

Return on investment: This may be calculated especially when capital is a short factor and it is important to obtain a highest possible interest on the investment. Divide the profit in the investment as specified above.

Break even point. Difference in break even point indicates difference in risk at lowest production degrees, and is given by the difference between fixed and variable costs. Calculate the break even point in % of the expected sales as;

$$\frac{\text{Fixed cost} \times 100}{\text{Fixed cost} \times \text{Profit before tax.}}$$

Cost diagram. Draw into the diagram the total cost lines for the different alternatives, showing how the total costs vary with the production volume in % of expected sales. At 100 % production the total costs will apply and at 0 production the fixed costs alone.

As long as only one machine is used for the alternatives, the costs line will occur as a straight line between these points and continue up to the maxim capacity for the machine.
When more than one machine is required, the additional ones do not need to be bought before they really will be required.
The fixed costs will than apply at stages.
For each machine that need to be added, the fixed costs will increase.

4. Choose Technology.

When the alternatives have been compared in the form as specified above, the choise remains very much simpler, and one will normally select the technology which has the lowest costs for the expected production volume.

The graphic cost diagramme gives however a good picture of how the costs develop for the different alternatives.
If it shows that other alternatives are more economical at reasonably lower production, may an other alternative possibly be a safer choise. If one is not completely sure that one really will be able to sell as much as planned, may it be better to go for a safer alternative.

If the graph shows that another alternative becomes more economical at a somewhat higher capacity, may this possibly based or a safe evaluation of future development, be a more right choise in the long run.

In addition to giving preference to projects with low fixed costs and low risk, one may also consider the amount of operators and give preference to the more labour intencive projects. These are however normally well correlated factors.

It may however also be wise to look a bit into the future, considering what may be the cost of labour in a few years to come. If one expect that working efficiency and labour costs in the near future will increase sharply determined by the technological development, may it be wise to embark on the less labour intencive alternative , to make sure that the project will be able to pay adequate salary rates also in the future.

Important is it also to judge what kind of product and technology development may occur in the lifetime of the project. Let us say that the product will have to change drastically in a few years to come, and that that will influence the production equipment. What is than better, either to embark on very well developed equipment that can cope with these changes, or to select simple equipment that can be exchanged without much problems ?
There is no general fasit answer to these questions. The matter must be judged in the individual cases.

Internal Rate of Return calculation. When the matter becomes complicated, if the above comparison does not give any clear picture, and when the matter is very important, can it be recommended to make forecasts for the development over say 10 years, estimating from year to year the changes in sales volume, prices and costs.

Than calculate the varying annual payments into and out from the activities and make a 10 year annual budget of payments including also the final salvage value of the equipment.
Based on these payment results one can than calculate the internal rate of return and see which alternative provides the best return on the invested capital.

Naturally that is a more complicated procedure, and there is no reason to go into such complications unless in special cases as indicated above.

For calculation of internal rate of return, when need be, use the form shown in appendix 5.

5. Collect Machine quotations for the selected technology.

Get quotations for machinery expected to be suitable according to the comparison betwen technologies as specified above. Try as much as possible to get the quotations from the original suppliers, i.e. the manufacturer or the representative importer.
They are the ones that knows their equipment best.
They are the ones who can modify the quotation, and who can also give the best quotation.

If it is not very clear which technology will be the best, you may still need to get quotations for different technologies, since the optimum choise than may depend on variations between specific suppliers.

Make sure that you will get quotations from all the important sources; those supplying the more relyable equipment, those with the different capacities, those with more specialized, and those with more versatile equipment, as well as those with the lower costs.

If you do not know who are the suppliers and where to get the quotations from, you will have to find out. Some times it is easy to find out, but with new technologies only scarcely available in some few far away countries, it can sometimes be quite difficult, and it may take time. But it is always possible. Do not give up, use your immagination about how to find out and try many different ways.

Talk to other manufacturers, and to suppliers of machines and raw materials, search in local and foreign trade directories and in the telephone yellow pages from different countries.
Contact suppliers and manufacturer's associations.
Get hold of the specific overseas trade journals.
Contract the commercial representations of the embassies. Contact the export or trade organizations in the supplying countries.
Contact the relevant institutes and universities.
See what has been written in newspapers, magazines and books.
And find out yourself who else may know better in you specific case.

6. Get to know the quoted machines.

As soon as you get the quotations try to find out;

a) Is it good enough and is it reasonable enough ? Can the quotation be used ? Does it fit well with the requirements ? Does it have any fair chanse of being selected as the best choise ?

b) Is enough information available about the equipment within the quotation or otherwise ? Is there encugh information about capability and capacity, consumptions, quality of performance, possibilities of faulty products, durability, service situation, versability varieties and tools, delivery and prices ?

1. If the quotation is not good enough, if it can not compete well with other alternatives, immediately let the supplier know how he stands, and give him chanse to come up with something better. If he can not, put his matter aside, but see if there are positive ideas from his side that can be utilized in other alternatives.

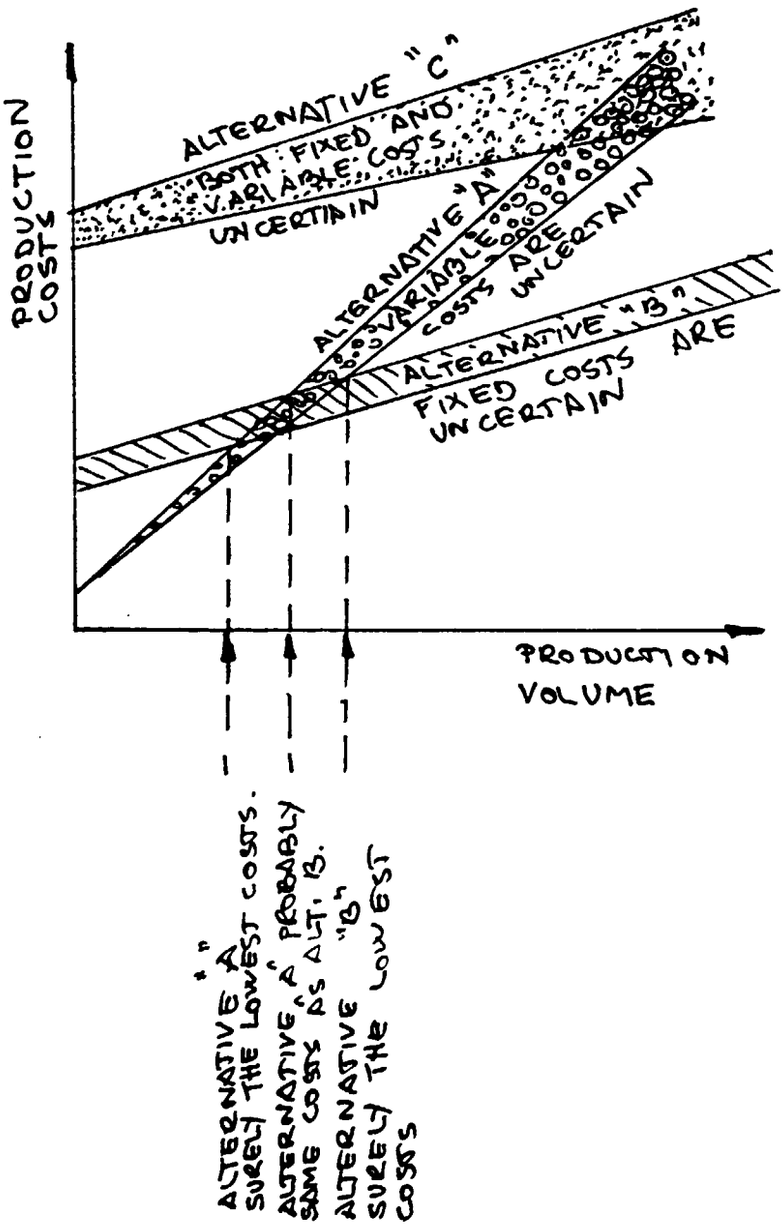
2. If the quotation appear acceptable, but important information is lacking, try to get an as good a clue about it as possible, and make sure that you finally will not be lacking so much information that the choise becomes uncertain.

First of all contact the supplier and let him clear off all doubtful points as far as possible.

It may however at times be difficult for him to specify matters which are extensively dependant on the particular use and operation of the machine. You may therefore also have to find out from others. Let him tell you who are the others using the same machine under somehow similar conditions, and equire with them. Let them explain you about the practical capacities they have reached, about operation costs and about possible problems they have experienced. Express it all as well as possible in figures; cost of maintenance reduction in no of working hours, extra administration and communication costs, etc.

If the supplier can not refer you to present users, you must be extra careful. If the users can not recommend the machine or if it is a completely new development, one may expect extra difficulties and costs.

If costs or capacities are uncertain one may have to calculate with 2 sets of figures, the optimistic and the persimistic assessment. The production cost diagram may hence come to look as follows when the uncertainties remain:



7. Compare the individual machine alternatives and select the best.

In step 3 and 4 the general technologies were compared and selected. Now the matter is narrowed down to comparing and selecting individual machines within the selected type of technology.

The way of working will however be exactly the same as described under step 3 and 4 above, and need not to be repeated here. In most cases will this be the natural way of working, first selecting technology; hand planing of wood, planing with a spindle cutter, or using a machine planing all 4 sides of the timber in one operation.
Finding that a single spindle cutter is the appropriate technology, one will collect offers for spindle cutter planers from different suppliers and compare the individual machines.

At times will it however be more practical to do the comparison of technology together with comparing individual machines. That may especially be so when very different alternatives are available within the unlike technologies and the choise of tecnnology becomes much a question about the individual machine.

8. Check the Selection and improve.

Look through the comparison and costing again and see whether you can be sure that your choise is the best one. What is wrong with the other alternatives ? Can anything be done to improve those matters ? If so may it happen that other alternatives may become the best ?

Inform the 2nd best suppliers about your choise, tell them why they are not selected, listen to their arguments to see if you have taken all matters into consideration. May it also happen that they can offer improvements in their alternatives ?

Also make use of a checklist to see if there are important considerations you have forgotten.

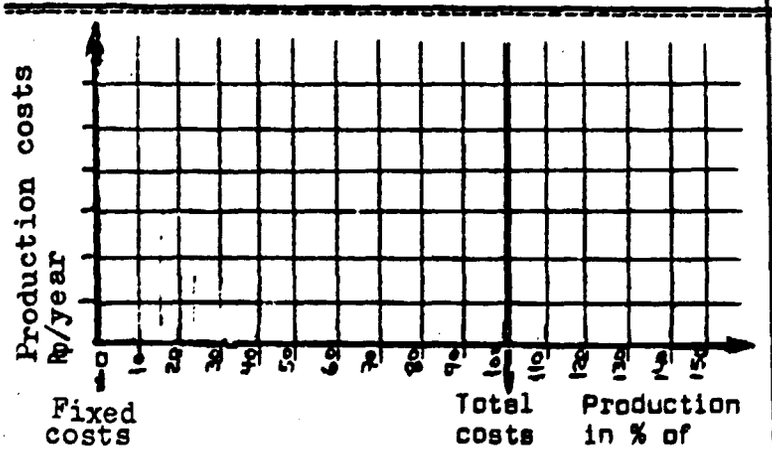
Also talk over your choise with other people in the trade to see if they can mention matters that you may not have given the right weight in you considerations. You may find that they have the practical experience that you are lacking.

Being finally sure that your choise is the right one, go ahead and implement your solution. Following the above recommendations you may have done the choise as well as possible. Before you buy a new machine the next time again, do not just trust your earlier selection and copy automatically.
First check whether your assessment were correct and see what kind of changes have developed in the meantime.

Good Luck !

APPENDIX 1.

Machinery Comparison Chart: OBS: Costs being equal for all the compared alternatives can be left out of the comparison!		Machine or Technology alternative: A=	B=	C=
Gross Machine capacity	items/hour			
x No of working hours per year	(2140hours/shift)			
x Speed utilisation factor	(50-100%)			
x Technical time utilisation factor	(50%-80%)			
x Personnel/administration efficiency factor	(60-90%)			
x Wreck production factor	(90-100%)			
x Seasonal factor	(30-100%)			
= Net capacity per machine	items/year			
Expected sales	items/year			
Required no of machines	number			
Required operation time for expected sales	% of no of shifts			
Product quality from the machine (Describe)				
Product price from this machine	(Rp./each			
Total sales	Rp /year			
Machine depreciation	% per year			
Rate of interest	%			
Floor space requirement	m^2			
Operators, skilled	No/shift			
Operators, less skilled	No/shift			
Waste of rawmaterials (incl. wreck)	%			
Cost of main machine as offered	Rp			
+ packing, seafreight, duty, salestax, clearing, local freight	Rp			
+ Additional equipment required	"			
+ Insallation of electricity, machinery, water etc.	Rp			
Total machinery cost	Rp			
Fixed costs: Depreciation	Rp /year			
Interest	"			
House rent	"			
Supervision	"			
Total fixed costs	"			
Variable Costs: Labour costs	Rp /year			
Maintanance				
Material costs incl. wastes	"			
Electricity	"			
Fuel, water etc.	"			
Total variable costs	"			
Total costs	Rp /year			
Sales less total costs	Rp /year			
Return on investment	%			
Break even point	%			



Conclusion:

Checklist for selection considerations.

Have you in your evaluation of equipment alternatives and cost comparisons taken into account these matters ?:

- Equipment on different technology level
- Different equipment on the same technology level
- That selection of some of the equipment in the factory can be done independant of each other.
- That other equipment selections may be dependant on each other.
- Limitation in capital availability.
- Return on investment on very different investments for other purposes.
- The possible differences in purchase and freight costs for the various machines.
- The possible differences in delivery time for the machines.
- The possible differences in installation costs for the machines, including fundations, electricity, connecting installations and equipment, etc, etc.
- Differences in capacity, and compared with the really needed capacity.
- Differences in capability, size of product etc.
- Differences in versability and adaptability.
- Differences in durability and need for maintenance.
- Differences in quality performance for the products in production.
- Differences in quality performance for wearing out and for becoming obsolete.
- Differences in space demand.
- Differences in health hazards and in accidental rate of the production.

Selection of technology - Exercise:

A bakery making 5.000 loaves of bread per day on 2 shifts require equipment for portioning of the dough into 500 g pieces for the individual loaves.

Equipment as follows on 3 different levels of technology may be considered:

A) An automatic electrically operated continuously working dough divider for 3.000 pieces per hour, available f.o.b England at £s 3,500.

B) An ordinary pointer scale for weighing up portions of 10 loaves lot. Thereafter dividing each portion into individual pieces of equal volume on a manual dough divider of capacity 800 loaves/hour.
Machine prices: Scale shs. 2,000, Divider £ 350 C&F Jakarta.

C) A pointer scale + a knife avaiable locally at shs. 1,500.
Operation speed for 2 operators together, 8 seconds per piece.

Make your own judgement for lacking information !

a) Make use of the comparison chart and complete it for all questions where the 3 alternatives are not equal. Determine the differences in yearly costs between the alternatives.

b) Complete also the cost diagram. Which equipment will you select and why ?

c) For which capacity would you make a different selection ?

Do not look at appendix 4 specifying a solution to the exercise before you have completed it yourself !.

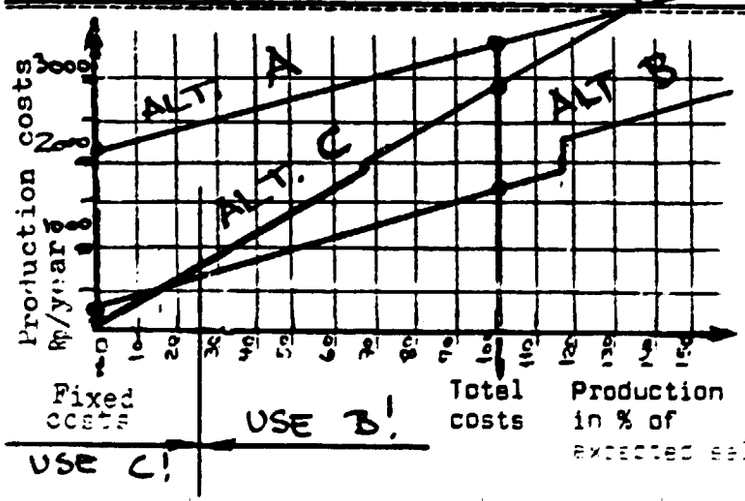
POSSIBLE EXERCISE SOLUTION:

Machinery Comparison Chart:

OBS: Costs being equal for all the compared alternatives can be left out of the comparison!

in 000 Rp.

		Machine or Technology alternative: A= CONTINUOUS AUTOMATIC ELECTR. DIVIDER	B= SCALE + MANUAL 10-DIVIDER	C= SCALE + HAND KNIFE
Gross Machine capacity	items/hour	3000	800	450
x No of working hours per year	(2140hours/shift)	4.280	4.280	4.280
x Speed utilisation factor	(50-100%)	0,8	0.8	0,8
x Technical time utilisation factor	(50%-80%)	0.70	0.72	0,75
x Personnel/administration efficiency factor	(60-90%)	0.9	0.9	0.9
x Wreck production factor	(90-100%)	0,99	0,99	0,99
x Seasonal factor	(30-100%)	1.0	1.0	1.0
= Net capacity per machine	items/year	6.400.000	1.757.000	1.030.000
Expected sales	items/year	1.500.000	1.500.000	1.500.000
Required no of machines	number	1	1	2
Required operation time for expected sales	% of no of shifts	24% - 2	85% - 2	73% - 2
Product quality from the machine (Describe)		SUFFICIENT	SUFFICIENT	SUFFICIENT
Product price from this machine	Rp./each			
Total sales	Rp /year			
Machine depreciation	% per year	10	10	10
Rate of interest	%	10	10	10
Floor space requirement	m^2	—	—	4
Operators, skilled	No/shift	0,5	1	2
Operators, less skilled	No/shift	—	—	2
Waste of rawmaterials (incl. wreck)	%	—	—	—
Cost of main machine as offered	Rp.	6.000	600	—
+ packing, seafreight, duty, salestax; clearing, local freight	Rp	x 1.7	x 1.54	—
+ Additional equipment required	"		200	300
+ Insallation of electricity, machinery, water etc.	Rp	200		
Total machinery cost	Rp	10.400	1.124	300
Fixed costs: Depreciation	Rp /year	1.040	112	30
Interest	"	1.040	112	30
House rent	"	—	—	40
Supervision	"	—	—	—
Total fixed costs	"	2.080	224	100
Variable Costs: Labour costs	Rp /year	700	1.400	2.800
Maintenance		500	50	10
Material costs incl. wastes	"	90	10	—
Electricity	"	100	—	—
Fuel, water etc.	"			
Total variable costs	"	1.390	1.460	2.810
Total costs	Rp /year	3.470	1.684	2.910
Sales less total costs	Rp /year			
Return on investment	%			
Break even point	%			



Conclusion:

ALT. B IS MOST ECONOMICAL FOR THIS CAPACITY

ALT. C MAY BE PREFERED FOR CAPACITIES LESS THAN 25 % OF THIS.

ALT A. MAY POSSIBLY BE ECONOMICAL ONLY FOR A VERY MUCH HIGHER PRODUCTION.

Calculation of Internal Rate of Return on alternative investments.

Year	Payments:	Total (z)	Net present value	
			At (x)% Interest	At (y)% Interest
0	Investment in the alternative	( )	( )	( )
1	Annual change in profit because of the investment.			
2	_ " _			
3	_ " _			
4	_ " _			
5	_ " _			
6	_ " _			
7	_ " _			
8	_ " _			
9	_ " _			
10	_ " _ Rest value of the investment.			
Sum			A=	B=

(The investment figures for year 0 to be written as negative figures). Calculate the net present value for the 2 different rates of interest for each year as: (for the x rate of interest).

Year 0 = Z
" 1 = $Z/(1+x)$
" 2 = $Z/(1+x)^2$
" 3 = $Z/(1+x)^3$
" 4 = $Z/(1+x)^4$

etc,etc.

Year 10 = $Z/(1+x)^{10}$

Determine the X and Y rates so that the sums A and B will be as close to 0 as possible, the one as positive the other as a negative figure. Internal rate of return,

IRR. $= X + \frac{A\ (Y - X)}{A - B} =$ _____ %