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Introduction

The aim of this guide

My aim in producing this guide is to provide a basic understanding of how to improve productivity in any business organization. I wanted to give it a provocative “In search of productivity”, but you don’t need to search for opportunities for productivity improvement—they exist in every workplace situation.

I have tried to keep it simple, practical and effective. It is not intended to turn you into a Work Study expert but if it arouses your interest in the subject there are several excellent textbooks you can turn to if you want to hone your skills. Improving productivity is not only necessary to the economic survival of an organization, but also to national prosperity. It also provides a new and absorbing dimension to your job— a constant challenge to do it better.

Who this guide is for

Managers, supervisors, trainers and employees at any level who wish to develop their understanding of productivity and their ability to improve the efficiency and utilization of resources in their organisations.

How to use this guide

Each of the eight sections has the same structure. Every section:

- takes a theme (listed in the contents)
- outlines the key issues
- gives examples of how those issues affect work
- suggests ways of handling the issues, in some cases with examples of what happened when other people used the approach.

Each section is self contained and can be read by itself, though they do of course relate to one another. Throughout the text you’ll features, all of which are designed to help make your learning as effective – and enjoyable – as possible. The features are as follows:

At the beginning of each section

Indicates a list of objectives – key activities that you should be able to carry out when you have completed the section. You’ll find a reminder in the Section Review at the end of each section to check back over this list.

At the end of each section

It suggests a personal agenda for action – a set of resolutions to put what you have learnt into practice. This is a reminder that the guide is about practical, attainable changes in working habits. One way of recording your agenda is as an ‘action plan’ – a list of targets with a date for the attainment of each. Here are some typical entries from one such plan:

- Determine the inputs, process and outputs of my job by 31/10.
- Improve the understanding and the importance of productivity of subordinates / colleagues by publishing my weekly indices (graphs and tables) 15/11
- Complete indices for all jobs and processes in my department by 25/7

There is also a summary of objectives for the whole of the guide on the next page.

1: What is productivity?

After completing this section you will be able to:

- Understand the concept of the production process
- Understand the concept of productivity
- Know the five ways to improve productivity

2: How productivity is measured

After completing this section you will be able to:

- Understand the importance of measurement;
- Calculate Single Productivity Ratios (SRP)
- Set standards of performance
- Calculate and maintain productivity indices (PIs)
- Calculate Total Resource Productivity (TRP)

3: What influences productivity

After completing this section you will be able to:

- Understand the term utilization and relate it to resources
- Understand the term efficiency
- Understand and recognize some of the factors that affect efficiency

4: How to measure utilization and efficiency

After completing this section you will be able to:

- Be able to apply the activity sampling technique to measure utilization
- Be able to apply the work sampling technique to measure efficiency
- Be aware of the technique of time study
- Understand the concept of work rating
- Understand the concept of standard time

5: Ways to improve productivity

After completing this section you will be able to:

- Look at work critically to look for productivity improvement potential
- Select and critically examine work
- Develop an alternative improved method
- Apply and measure the improved method

6: How to measure and improve clerical productivity

After completing this section you will be able to:

- Be able to measure clerical utilization
- Be able to measure clerical efficiency
- Identify the causes of low clerical productivity and take appropriate action
- Explain the advantages of improving productivity in-house

7: Profit from productivity

After completing this section you will be able to:

- Look at your organization, its inputs, processes and outputs in financial terms
- Understand that the lifeblood of any organization is money
- Understand key financial ratios

8: Setting up a productivity programme

After completing this section you will be able to:

- Understand the importance of gaining commitment at all levels when introducing a productivity improvement program.
- Carefully select and train suitable employees and form teams
- Select projects in consultation with others and maintain momentum

If you decide that you have not achieved what you set out to do:

- Discuss the objectives with someone – preferably your adviser. Have you interpreted these correctly? Have you set out to do too much too soon?
- Work through the relevant section of text again, taking particular note of the practical steps we recommend
- Above all, persist, if the objective is one you value the effort you put into achieving it, will be well worthwhile.

Cliff F. Grimes

cfg@accel-team.com

1. What is productivity?

After completing this section you will be able to:

- Understand the concept of the production process
- Understand the concept of productivity
- Know the five ways to improve productivity

So what is productivity? Well, for a start, productivity isn't half the things that people (who should know better) say it is. It does not mean

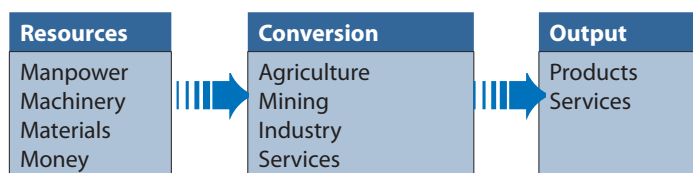
- working harder—unless people are loafing on the job;
- cutting costs—unless this can be done without affecting quality;
- reducing staff and workers unless your market is shrinking;
- extra work for managers—it's part of their job;
- employing specialists—it's a job for everyone.

There is nothing new about productivity. Early writings on the subject go as far back as 400 BC and by AD 1400 an efficient assembly line was working in Venice. By the 1800's the role of the worker in productivity had been recognized but it was not until the early 1900's that the modern approach to the productivity of industrial processes really came into being.

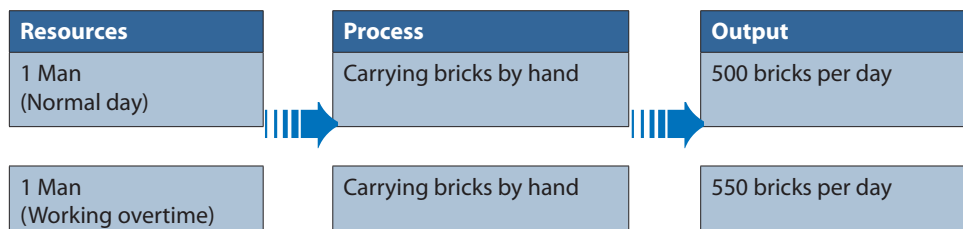
Since then the word "productivity" has become the best-used (and abused) word in the manager's and politician's vocabulary. Many people confuse production and productivity. Whilst both are important to any business they are really quite different in meaning. So let's clear up this misunderstanding before we go any further.

Production

Production is the process of converting resources into products or services. It is usually measured in terms of output per time period (e.g. boxes per hour, tones per day, bookings per month) or cost per unit of output (e.g. \$10 per box, \$20 per ton, etc). The objective of production operations is to meet the forecasted needs of the market in which they perform at the lowest possible cost.



The output of a production process can be improved by increasing the input of resources or by changing the process or both.



If we increase the resources by making a worker work overtime we will increase the output of the process and so meet our market needs. However we may not have improved

our costs in doing so.

Resources	Cost	Input	Output	Cost of output
1 man x 8 hours @ \$2.00 / hour	\$16.00	\$16.00	500 bricks	3.2 cents per brick
1 man x 8 hours @ \$2.00 / hour, plus	\$16.00	\$21.00	550 bricks	3.8 cents per brick (a 19% increase)
2 hours OT @ \$2.50 / hour	\$5.00			

If we can modify the process to enable the man to produce more without working harder or longer we may be able to meet our target and reduce the cost of output as well.

Resources	Cost	Input	Output	Cost of output
1 man x 8 hours @ \$2.00 / hour	\$16.00	\$24.00	800 bricks	3.0 cents per brick
1 wheelbarrow x 8 hours @ \$1.00 / hour	\$8.00			
60% increase				6% reduction

By adding to the resources and changing the process we have increased production by 60% and reduced the unit costs by 6%. That’s what productivity is all about.

Service Operations

In our examples so far we have tended to concentrate on the more traditional conversion processes which occur in agriculture, mining or manufacturing industry and which, until recently, formed the major part of business revenue.

Today they have been overtaken by the service industry which, in some Western countries, forms as much as 80% of all industry. Service operations make use of resources to create products just the same as does manufacturing industry although frequently the product is hard to visualize. Airlines, hotels, markets, chemist shops and garages are all examples of service operations which use manpower, machinery, materials and money to create a product or products which meet the needs of their customers.

When you arrive safely and comfortably at your destination your flight has been the product of a process which buys airplanes, maintains them, trains people to fly them and provide in-flight service, uses millions of units of fuel, food and toilet paper, and handles millions of items of baggage. The production of an airline can be measured in “Passenger / miles” and the cost and contribution of each resource can be similarly measured.

Exactly the same principles apply to the service divisions of a company such as personnel, finance and marketing. The product they produce must be defined and the resources involved must be used effectively. It is no more difficult to measure the output of an accounts clerk than a machine operator as we will show you later. Both have a contribution to make to the productivity of the company.

Productivity

Productivity is simply a measure of the ratio between the output of a process and the input of resources needed for it. It is usually expressed as output divided by input.

Output can be expressed in terms of units or volume (e.g. tones, litres, boxes, etc) and these units have usually been already determined for production planning purposes. In cases where outputs cannot be individually defined a monetary total can be used (e.g. \$s of production, \$s of sales, etc).

Inputs are usually separated into Manpower, Machinery and Materials. In cases where inputs cannot be segregated a monetary value can be substituted (e.g. £s of material).

Input	Unit of measurement
Manpower	Per manhour
Machinery	Per machine hour
Materials	Per materials unit
Money	Per \$ of input

The most commonly used measure of productivity is Manpower and it is the one usually referred to in the press when comparing our productivity with that of other countries. However, since manpower often forms a relatively low component of the total cost of a product it is vital to consider the productivity of all resource inputs when studying the productivity of a process.

In a large printing operation the relative costs of inputs expressed as a percentage of total direct costs were

- Manpower 25%
- Materials 40%
- Machinery 35%

A newly-appointed manager considered the operation overstaffed and, after a long and damaging conflict with the works union, succeeded in reducing the labor by 10% thus reducing overall costs by 2,5% for which he was warmly congratulated by the Board.

However, both the manager and the Board apparently overlooked the fact that materials wasted and spoiled in the process amounted to 10% (or 4% of total costs), whilst setup and cleaning time on the presses amounted to 30% of machine time (10,5% of total costs).

If the manager had devoted the same energy to improving the productivity of materials and machinery by reducing wastage and down-time by at least 50% as he had done in reducing labor he would have reduced total costs by more than 7% without running the risk of costly labor stoppages.

The term “machinery” is used to cover all the machines, equipment and transport used in the process. Similarly “materials” is used to cover not only raw or semi finished materials but also power, light, steam and other utilities consumed.

Improving Productivity

The cost of any product or service is the sum of the costs of the resources used in producing it. The more productive each of those resources can be made the lower the final cost of the product. In a free market the lower the cost of a product, the greater the demand it generates and the more profitable the enterprise, with ultimately a beneficial effect on the living standards of everyone.

Five Ways to Improve Productivity

- Increase input but get a greater increase in output.
- Maintain input but increase output.
- Decrease input with a smaller decrease in output.
- Decrease input but maintain output.
- Decrease input but increase output.

In a factory making domestic appliances the assembly operation for household fans comprised three workers. One attached the rotating mechanism to the base; one attached the motor and threaded the flex through the base; one fitted the fan blades and guard assembly. The complete fan then went off to the inspection department. The work was monotonous, labor turnover high and the number of rejects which had to be reworked was also high.

The factory manager attended a course on improving the content of work and, when he returned, decided to try out some of the things he had learned. He selected two workers and made each responsible for all the assembly operations—each turning out complete fan assemblies. He also made them inspect their own work and sign the guarantee label which was attached to the fan.

After a brief learning period they began to compete with each other and to take a pride in the quality of the work they turned out. The daily productivity figures changed dramatically.

System	Output	Rejects	%	Net Output	Manhours	Productivity
Old	60	10	16	50	24	2.1 / hour
New	48	2	6	45	16	2.8 / hour

So by decreasing the manpower by 33% and decreasing output by only 10% productivity increased by 33%. A similar decrease resulted in the cost of labor and materials per item thus making the product more profitable and/or more competitive. The spare worker could either be used full time or part-time to increase production (if the lower price increased demand) or could be employed in some other productive capacity.

Today, as ever, no organization, public or private, can afford to ignore the constant need to improve productivity nor can any employee evade his / her responsibility for playing their part in the work of productivity improvement. It's not difficult to do once you know the basics involved in measurement, standard setting and method improvement. The two most difficult parts of the operation are, firstly, starting it and secondly, keeping it going. We'll start to tackle the first one in our next chapter.

Section Review

- Productivity improvement is not a job for specialists only—it should be a part of every job in the organization.
- Although related, productivity and production are not the same thing. Production is the process of converting resources into products and is measured as the quantity produced in a given time.
- Productivity is the ratio between the output of a process and its inputs and is measured as output divided by input.
- Productivity improvement requires the optimal use of all resources —manpower, machinery, materials and money—not simply manpower alone.

Agenda for Action

What else do you intend to do now?

- Will you discuss with your boss your role in the search for productivity improvements and your possible contribution in this vital area to your organization?
- Have you identified all the inputs i.e. manpower, materials, machinery, in your job?
- Can you quantify all these inputs in terms of money?
- Can you identify the key outputs of your job?

2. How productivity is measured

After completing this section you will be able to:

- Understand the importance of measurement
- Calculate Single Resource Productivity ratios (SRPs)
- Set standards of performance (PIs)
- Calculate and maintain productivity indices
- Calculate Total Resource Productivity (TRPs)

One of the fundamental principles of productivity improvement is that the productivity of the existing process should be measured in as much detail as possible before any attempt to improve it is made.

At first sight this may appear to be an unnecessary restriction which cuts across many traditional ways of improving productivity, such as employee suggestion plans, think-tanks and the manager's or supervisor's own initiative in changing methods. Almost anyone who is observant can visit an operation and pick up a number of things that could be improved—people standing around, machines idle and so

All of these efforts may improve productivity of a particular operation or resource but these may not be the areas where the greatest improvement is needed and can be made. We saw an example of this in the last chapter when the manager picked on manpower for improvement when materials and machinery would both have contributed a greater improvement with less effort.

Alternatively, random efforts to improve may adversely affect the productivity of other resources leaving the company no better off than it was before.

A purchasing manager found a new material which, being easier to work, substantially reduced the manhours in a process. The works manager was delighted with the change because it improved his labor productivity, which management had been pressuring him to increase.

However, the new material cost more than the old so that the decrease in labor costs was offset by the increase in material costs. Whilst the purchasing manager had used his initiative to improve productivity, in fact the gain had been passed directly to the supplier of the new material and the company had not benefited from it at all.

The only sure way to prevent this happening is to establish accurate measurements of existing productivity so that possible changes can be fully evaluated against them before being introduced.

Single Resource Productivity (SRP)

The first basic measurement is Single Resource Productivity (SRP) which measures the productivity ratio of each individual resource broken down into as much detail as possible. To obtain Single Resource Productivity the output of a process (in either units or value) is divided by each resource input. The result is then expressed as a productivity ratio.

Output			SRP Ratio
300 boxes	=	20 manhours	15 boxes / manhour
Input			
Manpower			

The same method is used to measure all the other inputs of resources into the process.

Output			SRP Ratio
300 boxes	=	20 manhours	15 boxes / manhour
Input			
Manpower		10 machine hours	30 boxes / machine hour
Machinery		450 metres card	0.6 boxes / metre
Materials		2 litres glue	150 boxes / litre

But we said that we should break the various resources into as much detail as possible. For example, what types of labor are employed?

Output			SRP Ratio
300 boxes	=	Artisan - 8 manhours	37.5 boxes / manhour
Input		Assistant - 8 manhours	37.5 boxes / manhour
Manpower		Stacker - 4 hours	75 boxes / manhour

But what about the “stacker” who only does half a job anyway? He collects the finished boxes and places them on a pallet for periodic removal by a forklift truck. He serves two work stations so his time is split between them. Suppose it were possible to rearrange the work station so that, as the helper took a finished box off the machine, he was able to stack it on a suitably placed pallet. The stacker would no longer be required. The productivity of the artisan and helper would not change but the overall productivity of manpower would increase.

Output			SRP Ratio
300 boxes	=	20 manhours	15 boxes / manhour
Input			
Old Method		16 manhours	18.75 boxes / manhour
New Method			(25% improvement)

So it is only by measuring Single Resource Productivity in as much detail as possible that you can begin to see where productivity can be improved. Careful measurement also protects you from allowing productivity results to be masked by other factors such as profitability.

The company Chairman concluded his report by saying, “This has been a very difficult year for your company. Like many other employers we have had to meet demands for substantial wage increases and reduced working hours from our workforce. Due to the increase in transport charges our raw material costs have also risen.

However, because of the recession in the building industry, our efforts to increase sales volumes have been restricted and have ended up somewhat lower than last year. Luckily we were able to negotiate compensating increases in our selling prices. As a result I am glad to be able to report that our profits this year are on a par with those of last year and dividends will not be affected. I would like to extend the usual vote of thanks to our Managing Director and his able staff for maintaining the company’s productivity during this difficult period.”

The Chairman is not unique in confusing profitability and productivity. Profit can always be enhanced by improving productivity but it can also be increased by raising selling prices. In fact, increased selling prices often mask the results of decreased productivity as is obviously the case here. Without SRP ratios to guide you it is not possible to say whether productivity has been gained or lost.

However the SRP ratios alone will not help you much unless you have something to measure them against. Although, in the previous example, an increase of 25% in manpower productivity looks good on paper, 18,75 boxes per manhour may still be less than they achieve in the factory across the street or even in a factory in a developing country.

Only by comparing your results with a reliable norm can you check whether you are winning or losing the war on productivity.

Standards

In productivity improvement programmes the norm usually used is a productivity standard. This standard can be determined in several ways.

Setting productivity standards

- Use the results of a previous period - last 6 months, last 12 months etc.
- Use an outstanding result from a previous period
- Use an industry standard – most industries have developed performance norms
- Establish a standard by using work measurement and / or work sampling

The standard gives you something to aim for and something to measure against but it is not static. In fact, it must be changed whenever you change the inputs or the process otherwise its power to motivate will be lost and the results it throws out will be meaningless.

Productivity Index

Normal company reporting systems are a mixture of positive and negative figures; some indicate good results, some bad. For example when costs go down, that’s good but if production goes down, that’s bad. Interpreting positive and negative variances in such reports is tricky and time-consuming. Many managers don’t even attempt it, relying on their accountants to tell them when things have gone wrong —by which time, of course, it’s too late to do much about it. Since measuring productivity would be a waste of time and effort unless results were constantly reviewed and correctly interpreted, productivity results are

always expressed as a percentage of a standard —results above 100% are positive and results below clearly negative. This measure is known as the Productivity Index (PI).

Productivity Index	
Result being measured (actual) x 100	= PI
Standard	

The result being measured is multiplied by 100 so that the PI will be expressed as a percentage of the standard (100). Let's see how it works in practice. First you must find the Single Resource Productivity ratios of the process—in this case a gang making concrete with a small mixer.

Output 24 cubic metres (m3) of concrete			
Input			SRP
5 men x 8 hours	=	40 manhours	24 / 40 0.6 m ³ per manhour
1 mixer x 8 hours	=	8 machine hours	24 / 8 3 m ³ per machine hour
120 bags cement	=	120 material units	24 / 120 0.2 m ³ per material unit

At this stage you don't know whether these results are good or bad until you can compare them with some standard, in this case industry norms, and calculate Productivity Indices for each ratio.

Input	SRP	Standard		PI
Manpower	0.6	0.75	$(0.6 \times 100) / 0.75$	= 80%
Machinery	3.0	3.0	$(3.0 \times 100) / 3.0$	= 100%
Material	0.2	0.25	$(0.2 \times 100) / 0.25$	= 80%

Now you can see at a glance that you are running 20% below standard in manpower and materials. In each case you are getting less output from your resources than you should and therefore the finished product is costing more than it should. Obviously something must be done.

So you ask the foreman to reduce his gang by two men and to give them a proper measure for the cement so that they can only mix the correct amount. What happens to the SRP?

Output 20 cubic metres (m3) of concrete			
Input		Standard	PI
3 men x 8 hrs	=	24 manhours	20 / 24 0.83 m ³ per manhour
1 mixer x 8 hours	=	8 machine hours	20 / 8 2.5 m ³ per machine hour
80 bags of cement	=	80 material units	20 / 80 0.25 m ³ per material unit

The smaller gang wasn't able to keep up the same rate of production as the larger gang but productivity of manpower and materials seems to have improved. Let's check the Productivity Indices of the new method.

Input	SRP	Standard		PI
Manpower	0.83	0.75	$(0.83 \times 100) / 0.75 =$	111%
Machinery	2.85	3.0	$(2.85 \times 100) / 3.0 =$	83%
Material	0.25	0.25	$(0.25 \times 100) / 0.25 =$	100%

Apart from the fact that overall production is down (which may or may not be critical depending on the production plan) the foreman seems to have got well above the standard productivity from his gang and to have corrected the cement problem. But he dropped back 17% on machine productivity. Has the overall result been positive or negative? To find this out you need to use the second basic measure of productivity.

Total Resource Productivity (TRP)

So far we have been concentrating on the productivity of the individual inputs into a process, and we have seen how changes in input and output can affect productivity.

However, sometimes an improvement in the productivity of one resource input will cause a deterioration in another (as in the last example). In these cases you need to be able to check and compare the overall productivity of the process. For this purpose we use Total Resource Productivity (TRP).

Old Method				
Input			Output	
40 manhours @ \$1.5	\$60	\$900	=	24 m ³ concrete
8 machine hours @ \$15	\$120			
120 material units @ \$6	\$720			
Total Resource Productivity	= 24 / 900		0.026 m ³ per \$ input	

In order to find the TRP all inputs are converted into monetary values, added together and divided into the output to establish the output per \$ of input. Let's apply it first to the old method of making concrete.

Using the same input values you can calculate the TRP of the new method.

New Method				
Input			Output	
24 manhours @ \$1.5	\$36	\$636	=	20 m ³ concrete
8 machine hours @ \$15	\$120			
80 material units @ \$6	\$480			
Total Resource Productivity	= 20 / 636		= 0.031 m ³ per \$ input	

Checking the Productivity Indices of old and new methods you can see whether or not the changes made by the foreman have in fact increased overall productivity.

$$\frac{(\text{actual} \times 100) / \text{standard}}{(\text{actual} \times 100) / \text{standard}} = \frac{(0.03 \times 100) / 0.026}{(0.03 \times 100) / 0.026} = 115\%$$

So you have improved by 15% which seems very good but is it the best you can get? Using the previous standards as a guide the standard TRP for the process works out at 0.030 m³ per \$ input. You can now measure your new performance against the standard.

$$\frac{(\text{actual} \times 100) / \text{standard}}{(\text{actual} \times 100) / \text{standard}} = \frac{(0.03 \times 100) / 0.032}{(0.03 \times 100) / 0.032} = 94\%$$

So, although you have done well to improve productivity you still need to improve some more which will probably mean bringing back another man to get the production up and keep the machine operating at 100% capacity. And of course you don't have to be satisfied with reaching the standard—you can and should always try to beat it.

One last point—always use the same base costs when calculating the Total Resource Productivity of more than one process or the same process at different times (e.g. last year versus this year). Obviously changes in costs will throw out the validity of the comparison.

Section Review

- Single Resource Productivity measures the productivity of each individual input as a ratio of output to input. The more detailed the breakdown of inputs the greater your ability to spot areas needing action.
- Standards of productivity must be set so that results can be compared with a standard to provide meaningful variances for investigation.
- Productivity Index is a method of uniformly reporting results as a percentage of standard performance.
- Total Resource Productivity is used to compare the overall productivity of all resource inputs with other results or standards. It is found by converting all the inputs into monetary values, adding them together and dividing them into the output to give the output per £ of total input.
- It is a fundamental principle of productivity improvement that productivity should be measured before any attempt is made to improve it. Equally important is to ensure it is re measured after every change in the process or resource inputs.
- Reporting productivity results as indices of standards should form a part of the regular reporting system of any company that seriously wants to improve its productivity.

Agenda for Action

What else do you intend to do now?

- Can you suggest how, in your work situation, the reporting of productivity can be improved? For single resources and total resources?
- Can you now produce a productivity index or indices for your work that would improve the measurement and reporting of productivity?
- How will you go about producing and reporting these ratios and indices? Will you use a computer generated graphs enabling trends to be picked up over time? Would it be advantageous to use moving averages or curve fitting techniques to the underlying data?