PN-ADC-647

AGRICULTURE-LED EXPORT BUSINESSES (ALEB)

Supporting Egypt's Processed Foods Export Industry

Managing Cost for Export Efficiency, Case Studies and Applications

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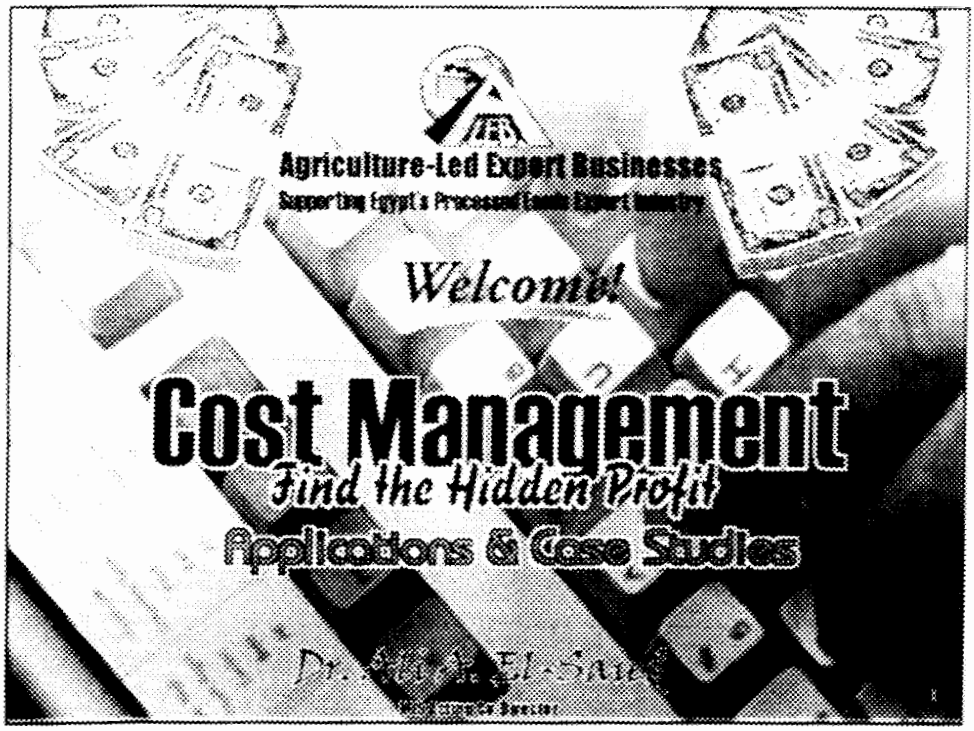
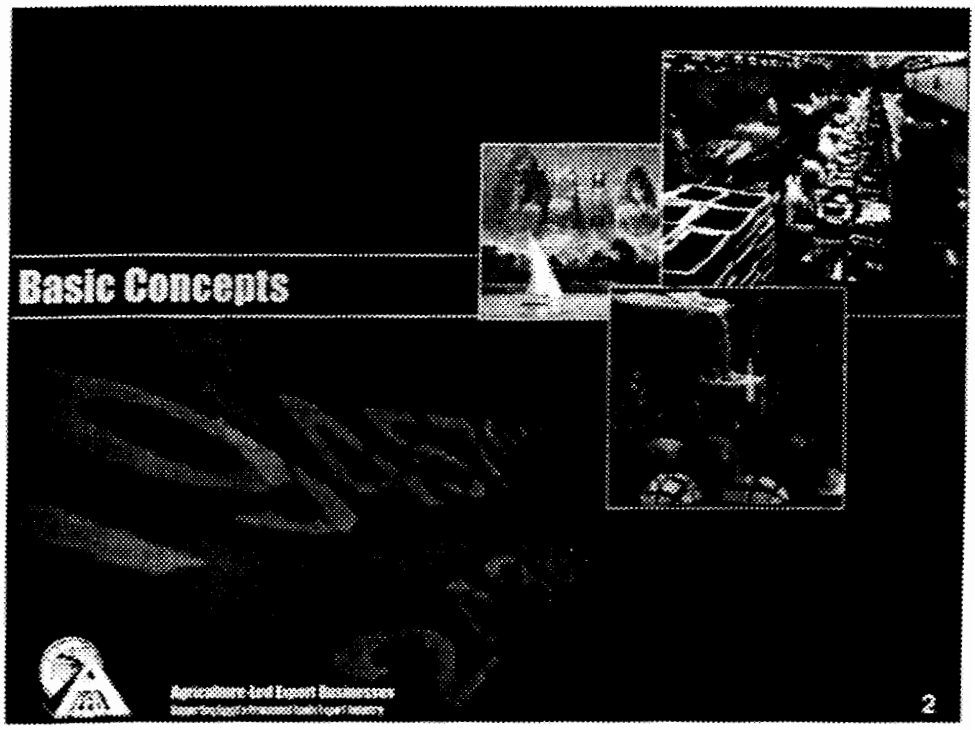
July 24-25, 2002

Hotel Mercure, Alexandria

Implemented by Abt Associates & funded by the United States Agency for International Development.
Project no. 263-0264


Agriculture-Led Export Businesses
Welcome!
Cost Management
Find the Hidden Profit
Applications & Case Studies


Basic Concepts
2

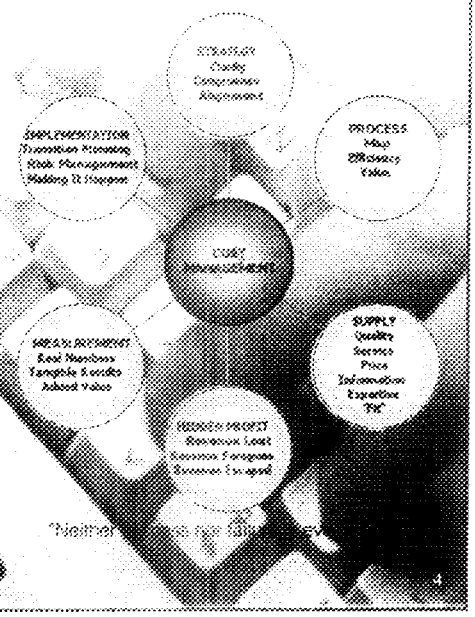
Cost Management

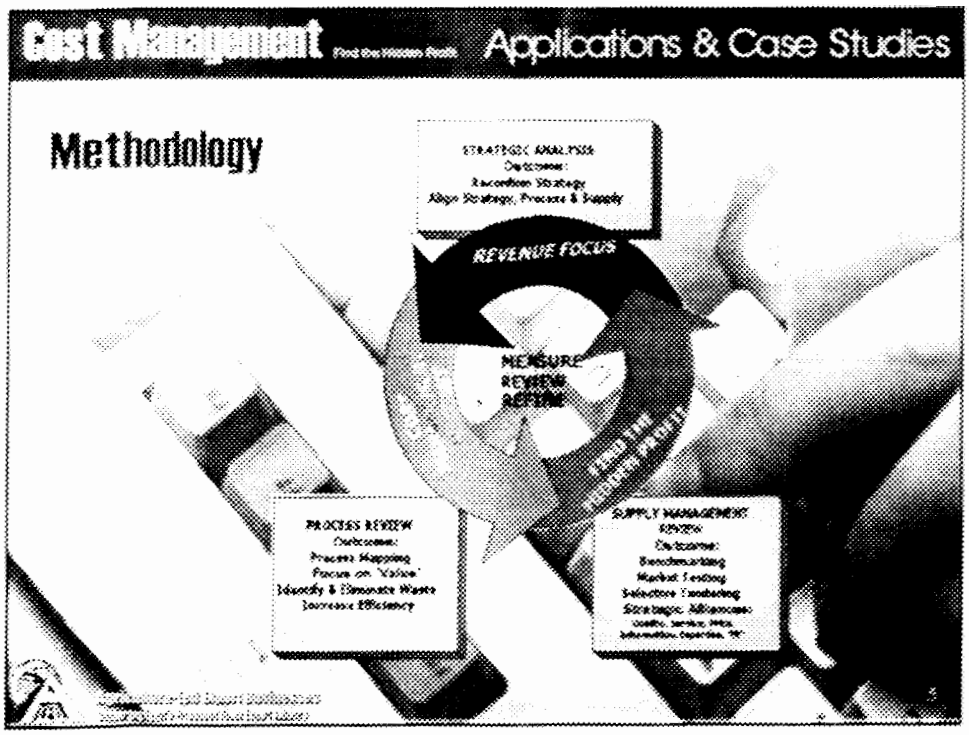
Find the Hidden Profit

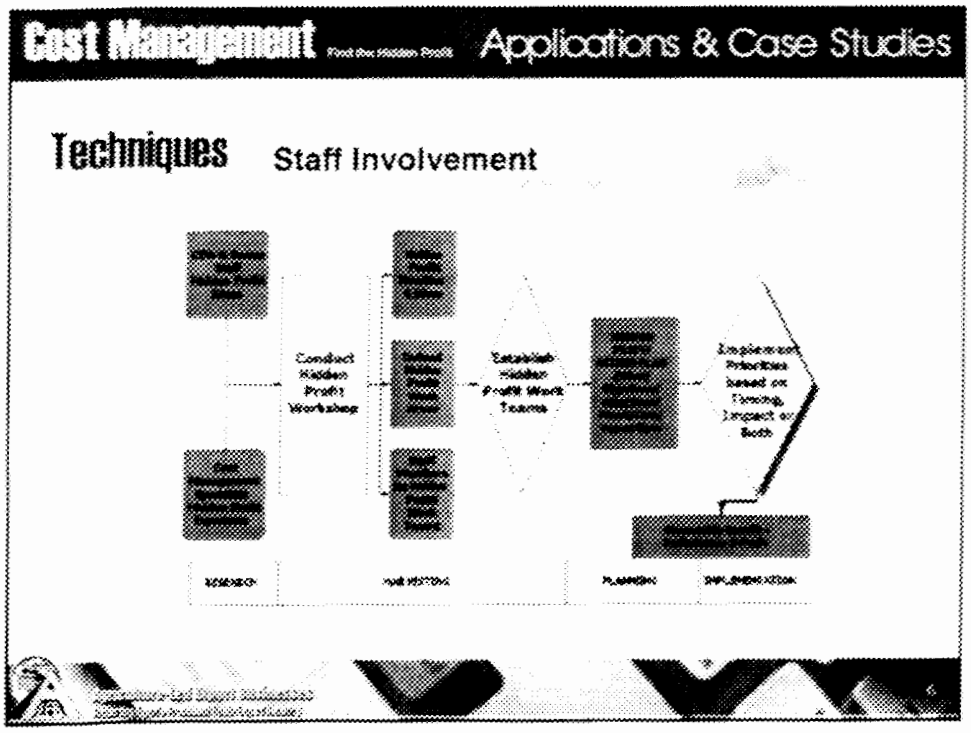
- FIND THE HIDDEN PROFIT IN YOUR BUSINESS
- COST MANAGEMENT - THE ULTIMATE COMPETITIVE ADVANTAGE
- PROFITABLE & UNPROFITABLE BUSINESS
- MAKING AN INFORMED CHOICE
- PROCESS MAPPING FOR ADDED VALUE
- ADDING FINANCIAL SKILLS TO YOUR MANAGEMENT TOOLKIT
- SELLING PROFESSIONAL SERVICES PROFESSIONALLY
- MANAGING & NURTURING A STRATEGIC ALLIANCE
- SUPPLY CHAIN MANAGEMENT - THE MULTIPLIER EFFECT
- OUTSOURCING - MANAGEMENT REACTION OR STRATEGIC INITIATIVE
- NETWORKING & REFERRAL
- BUSINESS DEVELOPMENT IN YOUR BACK YARD

Cost Management *Find the Hidden Profit* Applications & Case Studies

Cost Management is to Find the Hidden Profit in your business. Focus on the interrelationship between Strategy, Process, Revenue and Cost. We use this interrelationship to focus on the management of cost not simply measurement. Not just numbers, but information to make informed decisions and achieve strategic results.




Cost Management
Applications & Case Studies
Methodology
REVENUE FOCUS
MEASURE
REVIEW
REFINE
PROCESS REVIEW
Outcomes:
Process Mapping
Focus on 'Value'
Identify & Eliminate Waste
Increase Efficiency


Cost Management
Applications & Case Studies
Techniques
Staff Involvement
Conduct
Hidden
Profit
Workshop

Techniques

Analyze four key revenue streams.

Type of Revenue	Examples
Revenue Received	Financial statements analysis
Revenue Lost	Waste, duplication, inefficiency, unprofitable customers, extravagant consumption. Often these examples reflect history or a culture no longer in the clients best interest
Revenue Foregone	Maximising existing customer base, utilising resources more effectively, a systems approach. Opportunity is in the eyes of the beholder. We bring trained cost management eyes and an opportunistic approach
Revenue Escaped	Fraudulent use of funds for private purposes, lack of internal controls or breach of those controls. The statistics on fraud are frightening!

Techniques

Identify how to increase revenue while managing cost within the corporate strategy. Examples of some of the indicators Cost Management Specialists use are:

INDICATOR COST MANAGEMENT PERFORMANCE MEASURES	FINANCIAL INDICATORS
Profitability	Earnings, earnings trends.
Liquidity	Cash flow, cashflow trends, banking and financial services, interest coverage, asset turnover, inventory turnover, receivables turnover.
Sales	Sales in critical product [illegible] trends, sales [illegible]

Cost Management — Applications & Case Studies

Techniques

Identify how to increase revenue while managing cost within the corporate strategy. Examples of some of the indicators Cost Management Specialists use are:

CUSTOMER INDICATORS

Customers Customer Profitability, Returns, Complaints, Surveys, Market research.

Quality On time delivery performance, time from order to customer receipt Customer complaints, warranty expenditure, service effectiveness

Cost Management — Applications & Case Studies

Techniques

Identify how to increase revenue while managing cost within the corporate strategy. Examples of some of the indicators Cost Management Specialists use are:

INTERNAL BUSINESS INDICATORS

Quality Number of defects, numbers of returns, customer survey, scrap, rework, field service reports, warranty claims.

Process Mapping Conceptualising, mapping, reviewing and redesigning processes for greater efficiency, remove bottlenecks and exploit opportunities.

Productivity Setup time, cycle time, labor & machine efficiency, scheduling, downtime, machine utilisation/capacity, preventative/reactive maintenance...

Cost Management Find the Hidden Profit — Applications & Case Studies

Techniques

Identify how to increase revenue while managing cost within the corporate strategy. Examples of some of the Indicators Cost Management Specialists use are:

LEARNING AND INNOVATION INDICATORS

Deliberate Thinking Ability in creatively reflect on the future and define what future success means. Stimulate creative and counter intuitive thinking. Motivate staff evaluation of the value in what they do and how to creatively identify how to add more value. Demonstrate a cost management mindset.

Training Behavioral change for enhanced results. Whatever the topic, we bring a strategic focus. We also promote the philosophy of life long learning.

Systems Bias Systems review and modification based on experience, opportunity and a commitment to continuous improvement.

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Cost Management Find the Hidden Profit — Applications & Case Studies

Profit Planning
and Cost Management
Example

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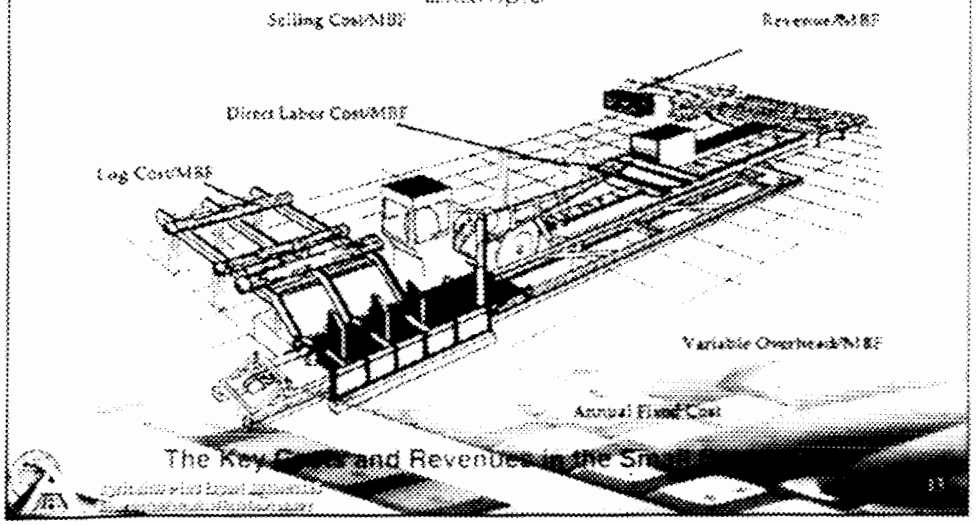
Profit Planning and Cost Management

Example



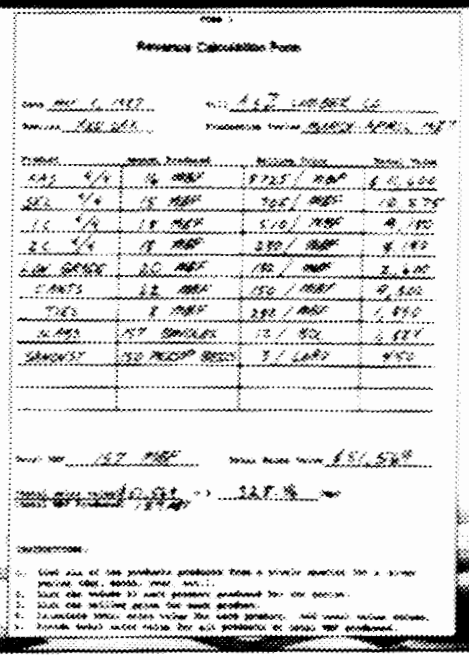
The Key Costs and Revenues in the Sm

Cost Management Applications & Case Studies

Profit Planning and Cost Management

Example

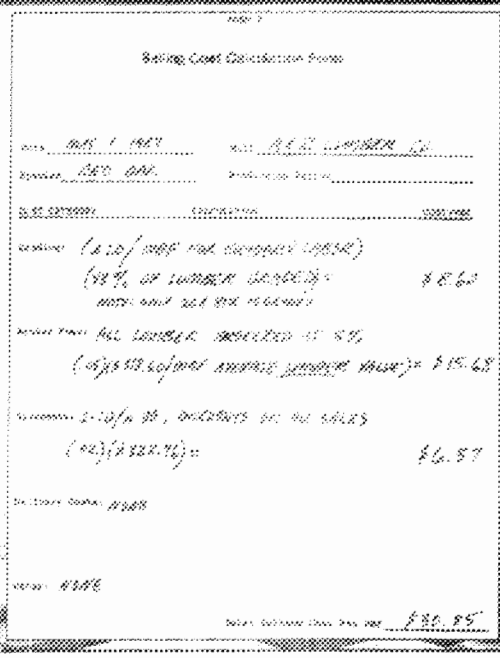
Revenue Calculation Form



Profit Planning and Cost Management

Example

Selling Cost Calculation Form

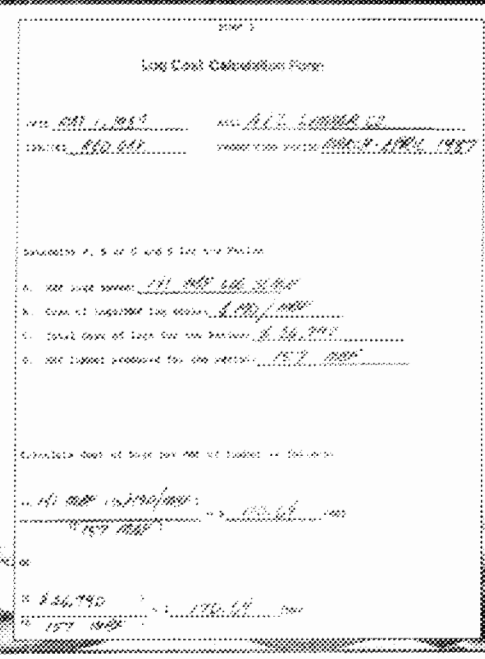


Cost Management Applications & Case Studies

Profit Planning and Cost Management

Example

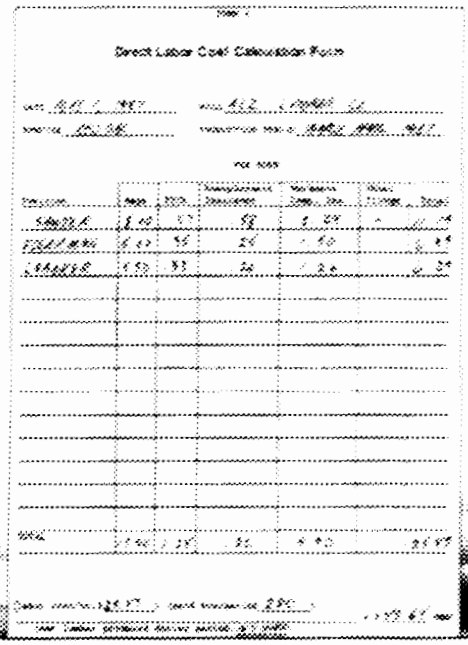
Log Cost Calculation Form



Profit Planning
and Cost Management

Example

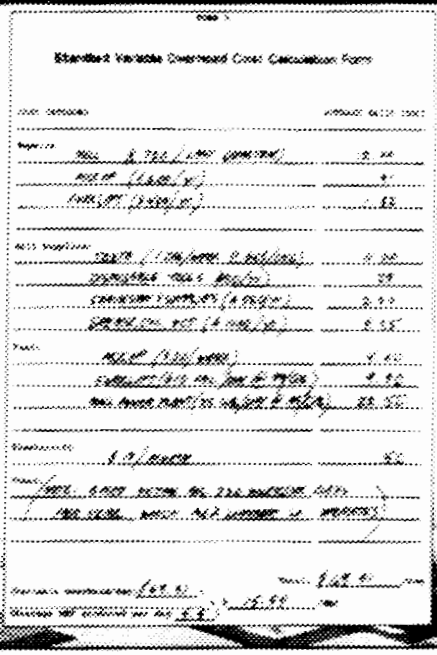
Direct Labor Cost
Calculation Form



Profit Planning
and Cost Management

Example

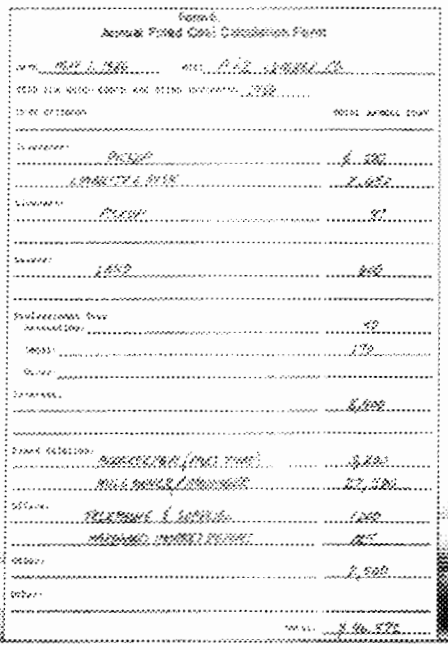
Standard Variable
Overhead Cost
Calculation Form



Profit Planning and Cost Management

Example

Annual Fixed Cost Calculation Form

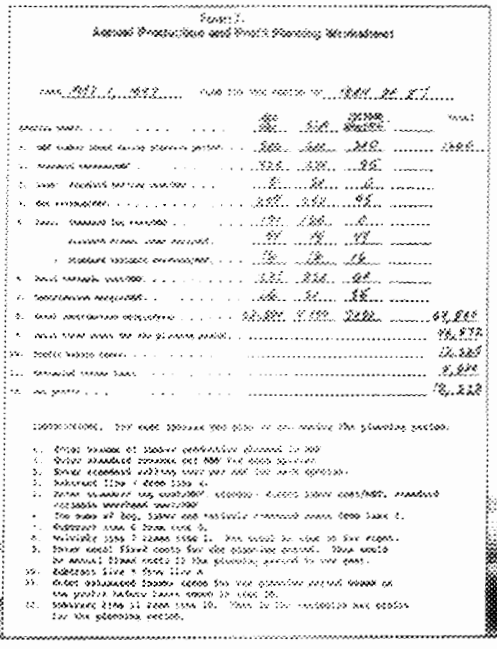


Cost Management Find the Hidden Profit Applications & Case Studies

Profit Planning and Cost Management

Example

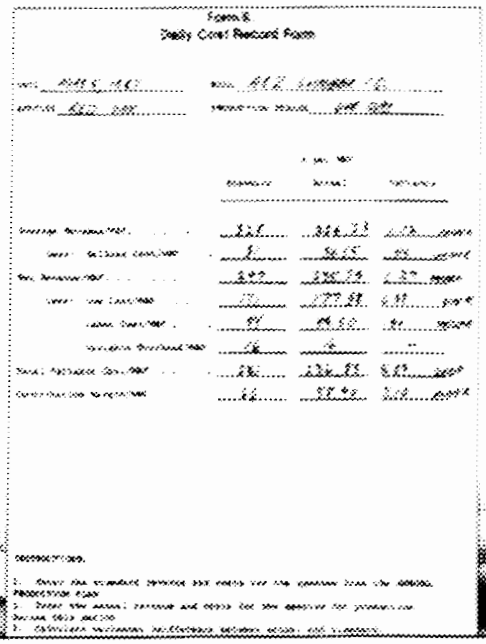
Annual Production and Profit Planning Worksheet



Profit Planning
and Cost Management

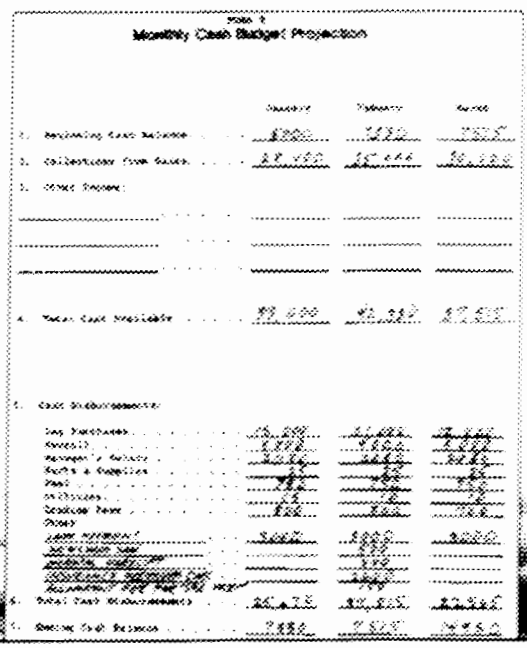
Example

Daily Cost Record Form



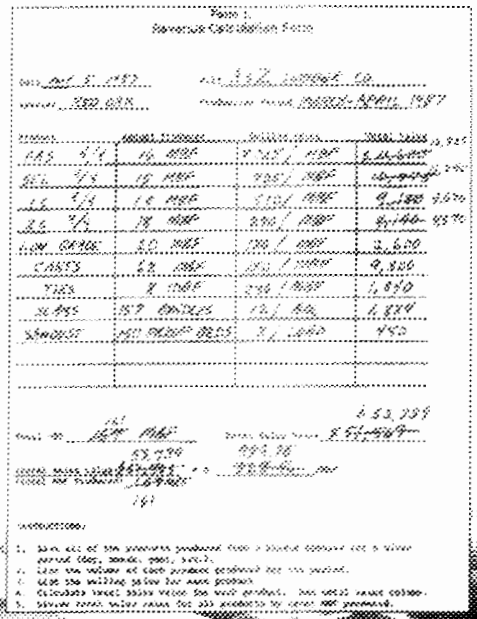
Profit Planning
and Cost Management

Example



Profit Planning
and Cost Management

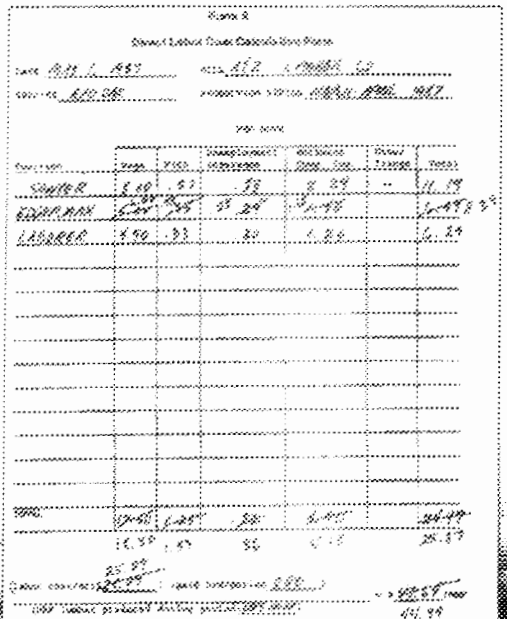
Example



Cost Management Applications & Case Studies

Profit Planning
and Cost Management

Example



Profit Planning
and Cost Management

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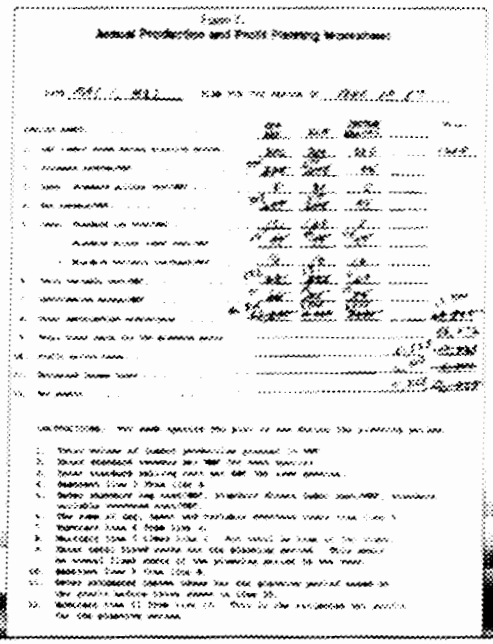

Profit Planning
and Cost Management

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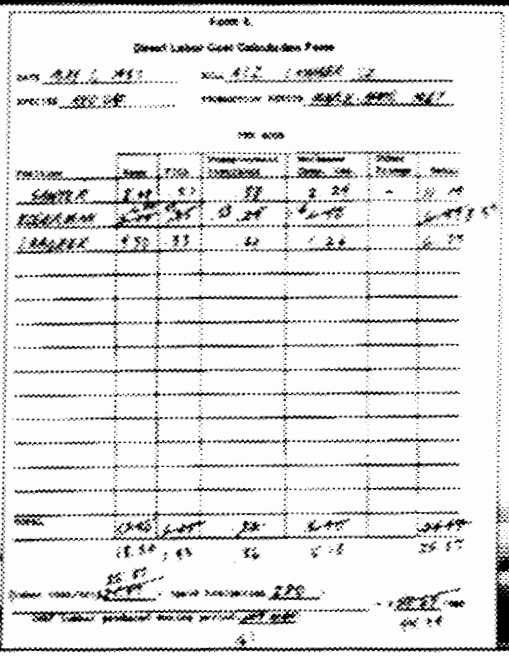

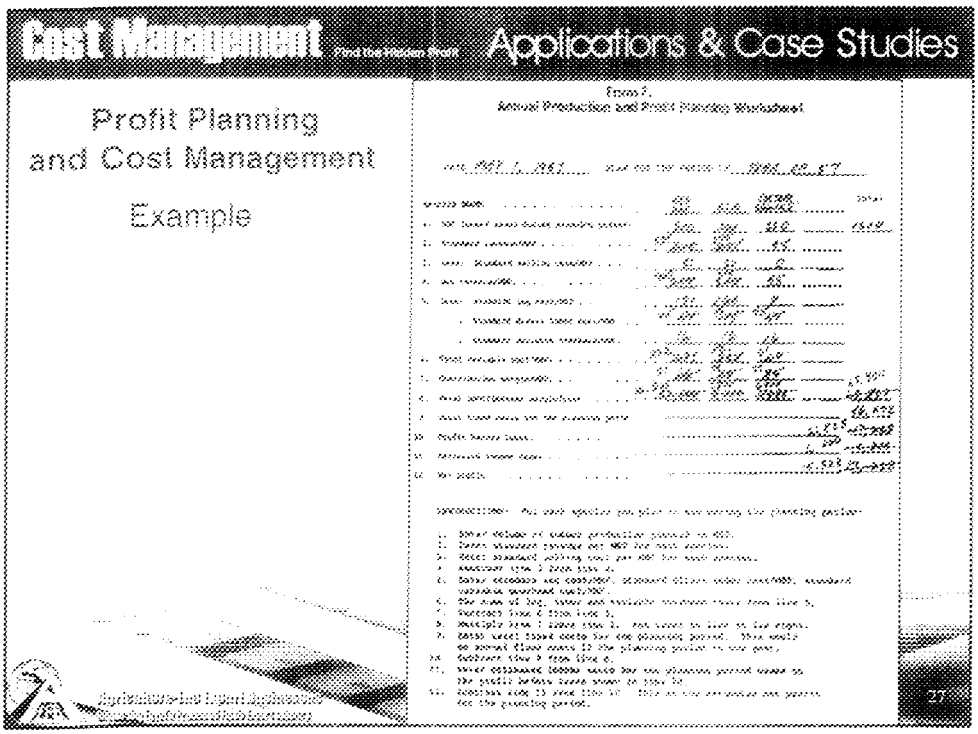
Cost Management
Applications & Case Studies
Profit Planning
and Cost Management
Example
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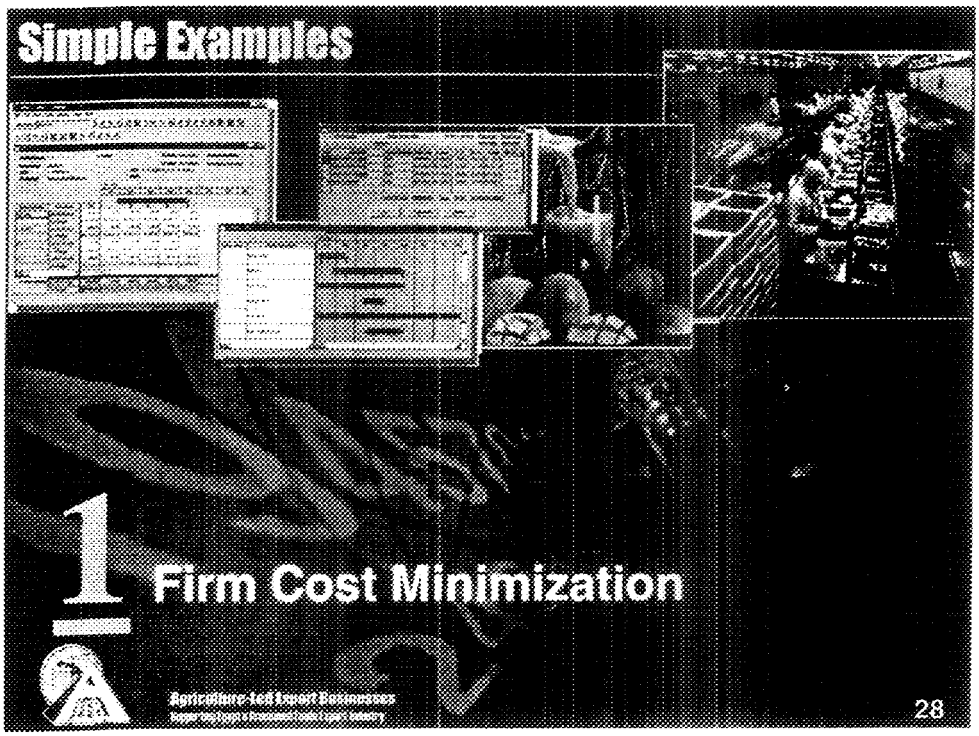
Simple Examples
1
Firm Cost Minimization
Agriculture-led Export Businesses
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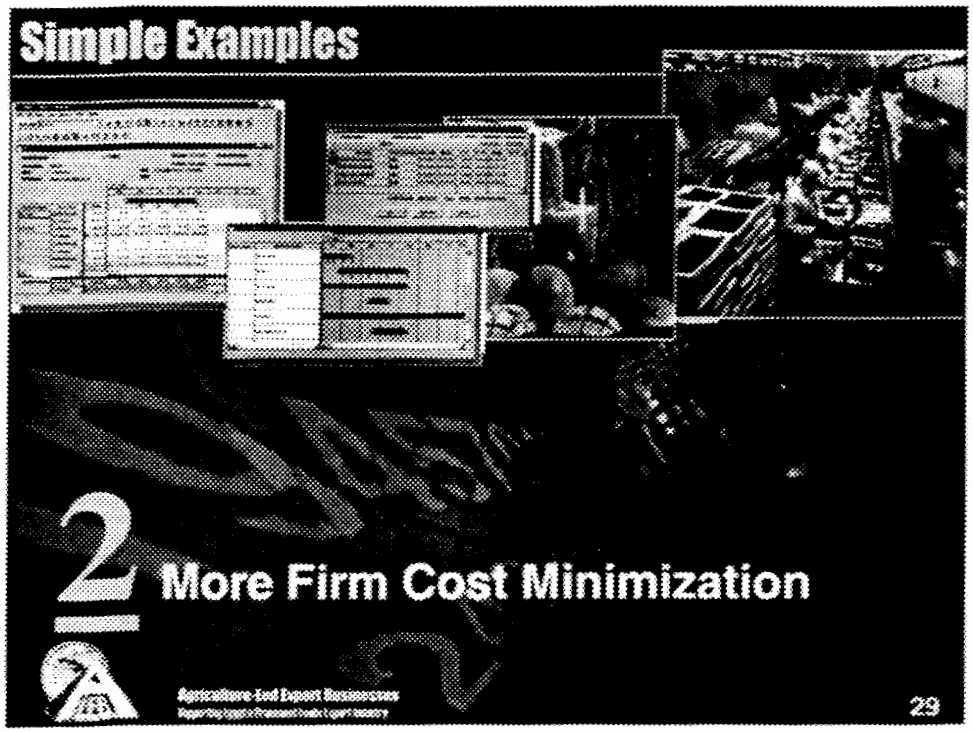
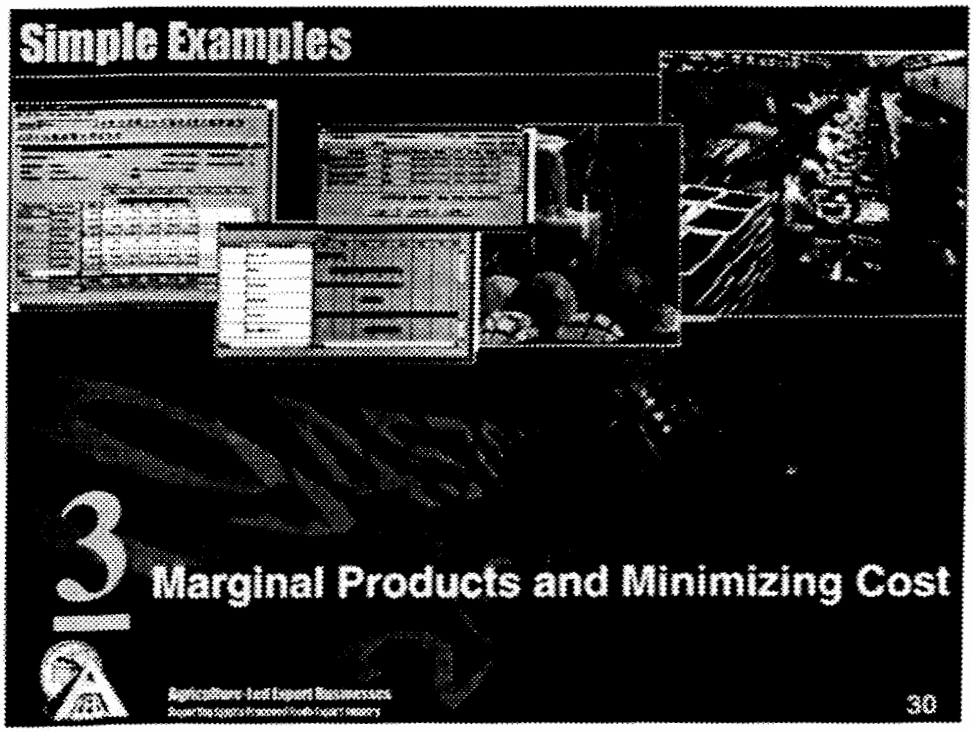
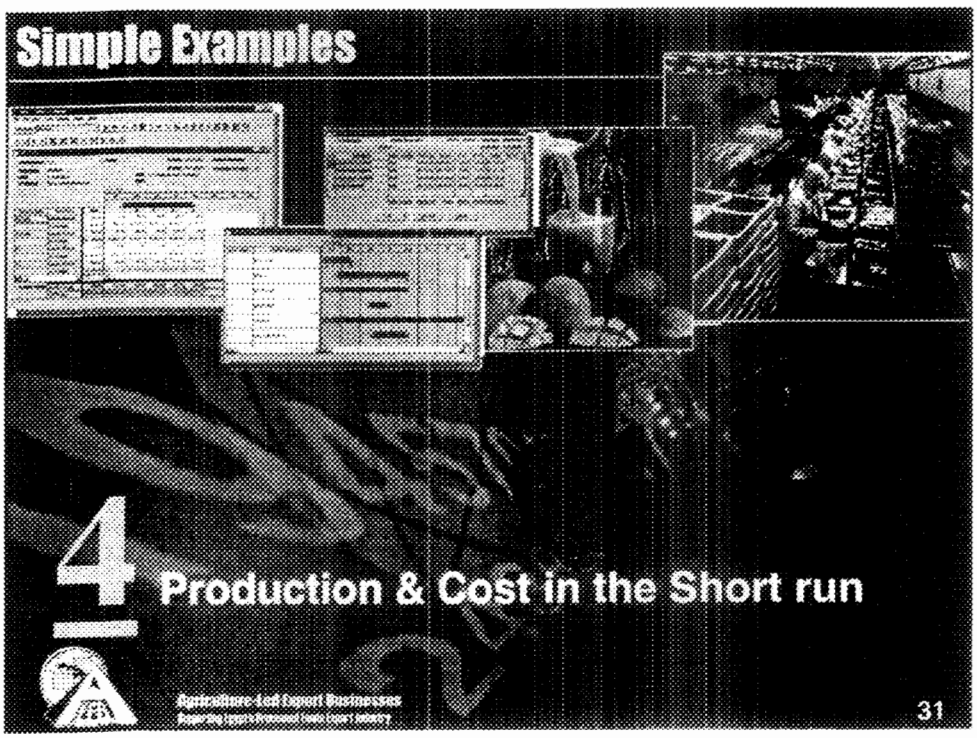
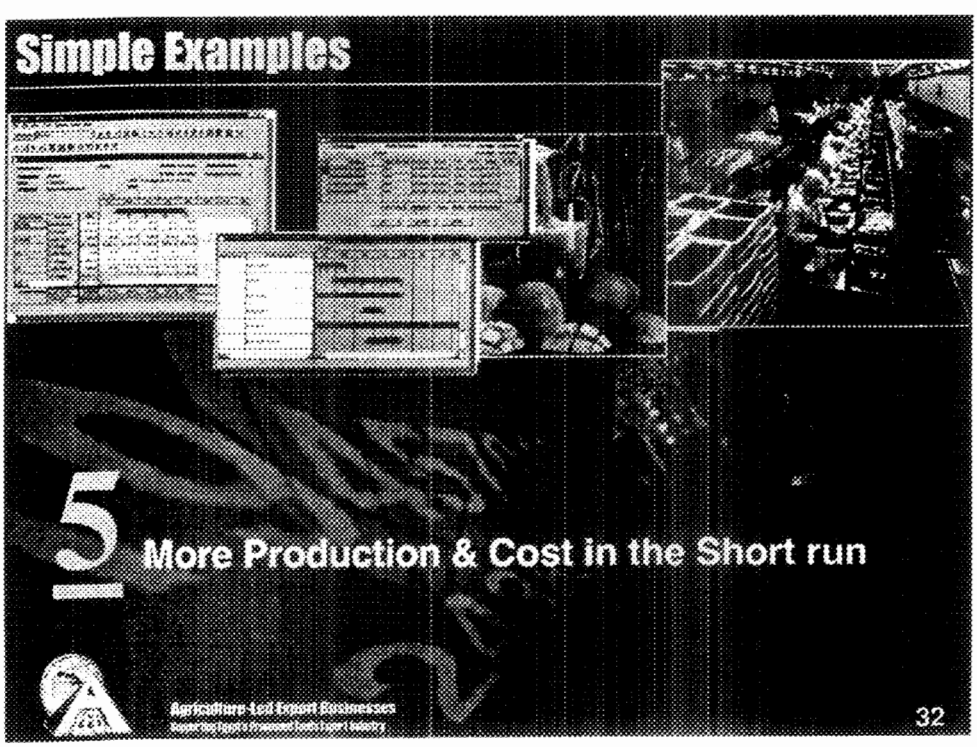
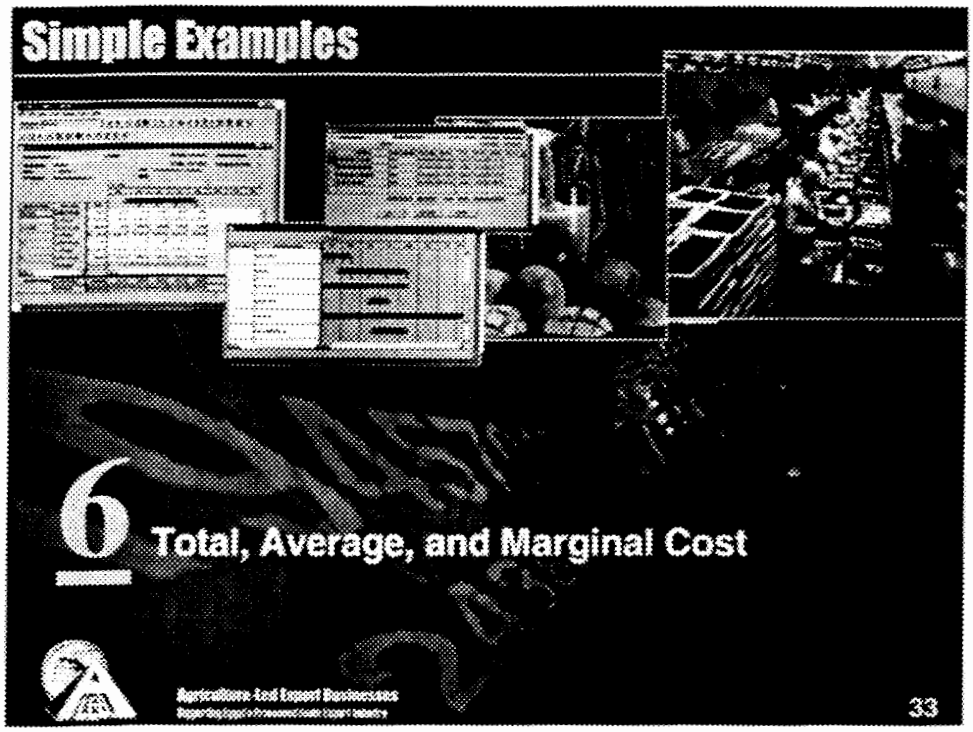
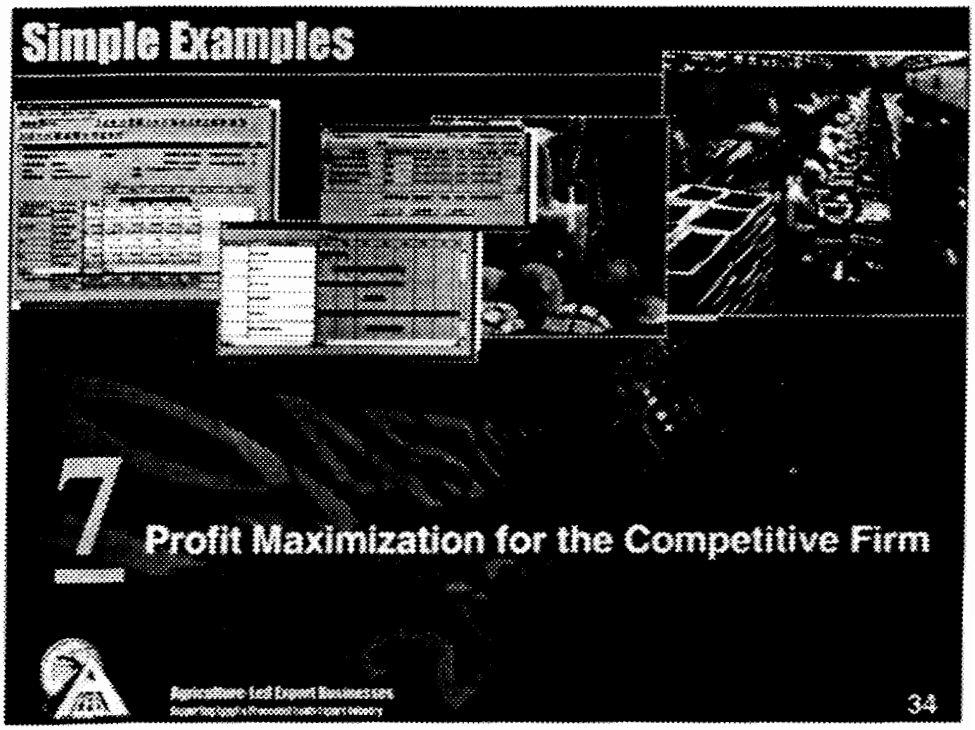

Simple Examples
2 More Firm Cost Minimization
29

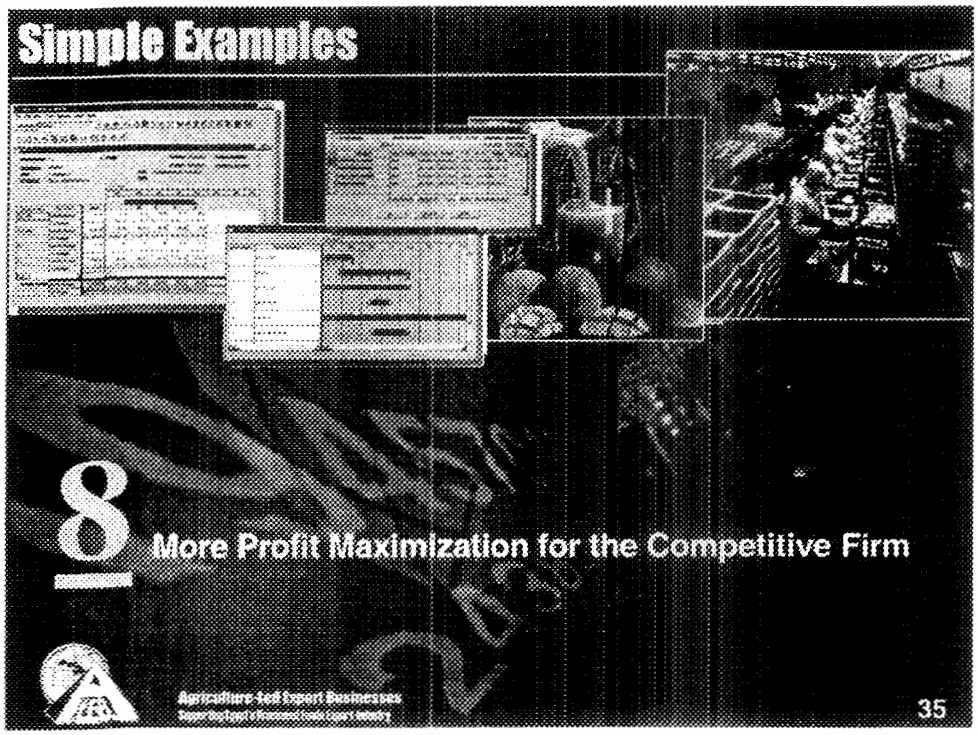

Simple Examples
3 Marginal Products and Minimizing Cost
30

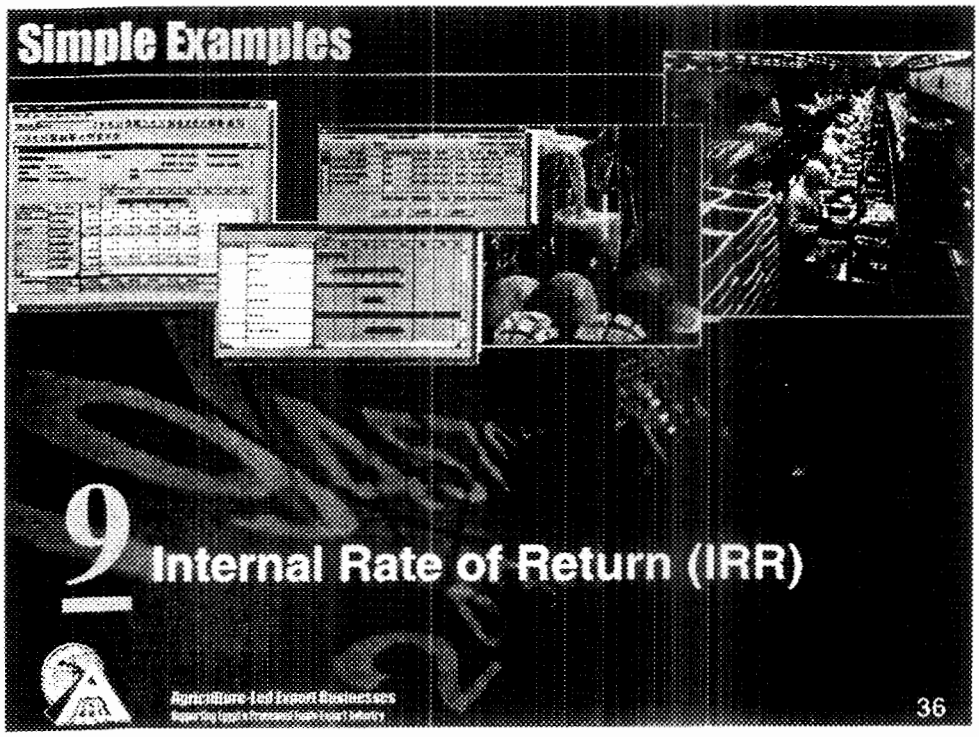

Simple Examples
4
Production & Cost in the Short run
Agriculture-Led Export Businesses
31


Simple Examples
5
More Production & Cost in the Short run
Agriculture-Led Export Businesses
32


Simple Examples
6
Total, Average, and Marginal Cost
33


Simple Examples
7
Profit Maximization for the Competitive Firm
34


Simple Examples
8
More Profit Maximization for the Competitive Firm
Agriculture-led Export Businesses
35


Simple Examples
9
Internal Rate of Return (IRR)
Agriculture-led Export Businesses
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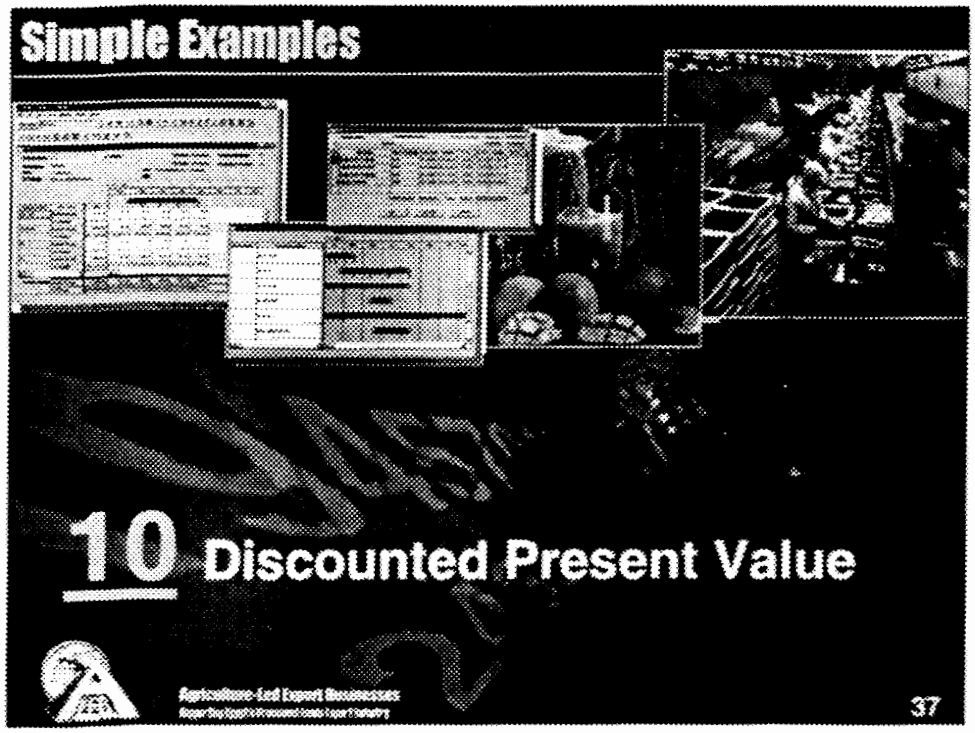
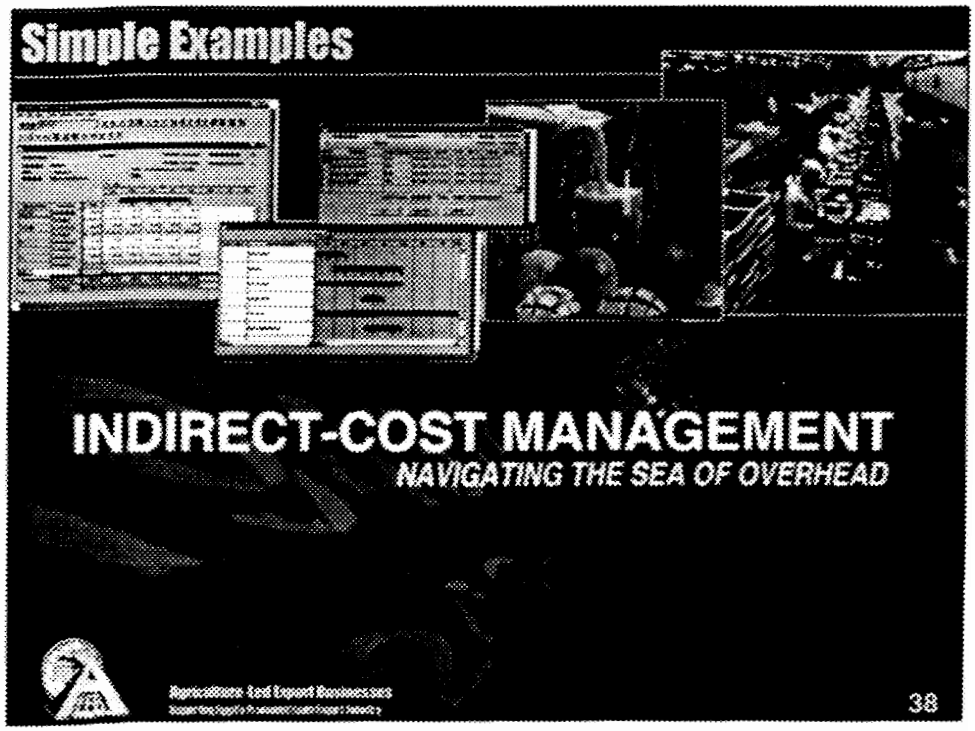

Simple Examples
10 Discounted Present Value
37


Simple Examples
INDIRECT-COST MANAGEMENT
NAVIGATING THE SEA OF OVERHEAD
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Indirect Cost Management

NAVIGATING THE SEA OF OVERHEAD

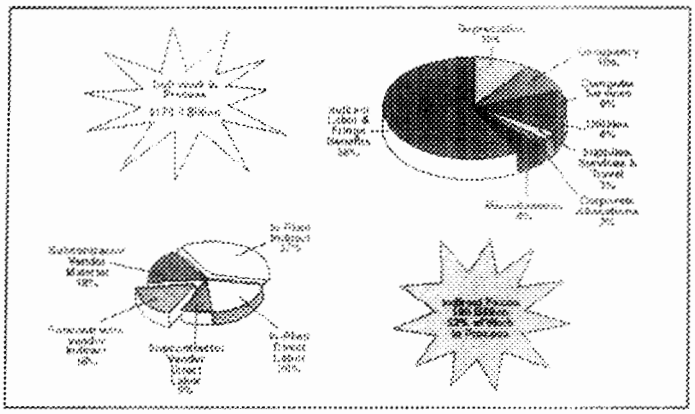


Exhibit 1. Significance of Indirect Costs

Cost Management Find the Hidden Profit Applications & Case Studies

Indirect Cost Management

NAVIGATING THE SEA OF OVERHEAD

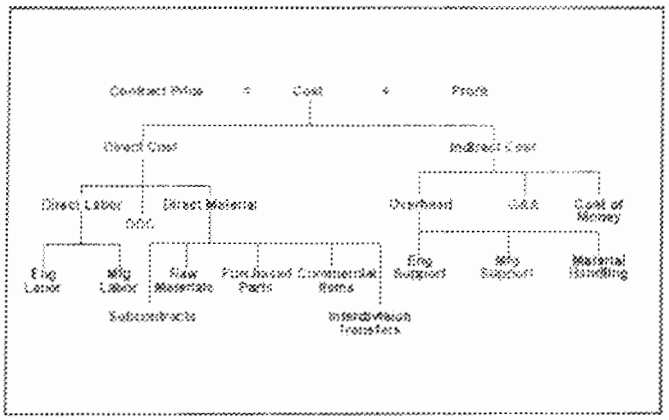


Exhibit 2. Components of Contract Price

Indirect Cost Management

NAVIGATING THE SEA OF OVERHEAD

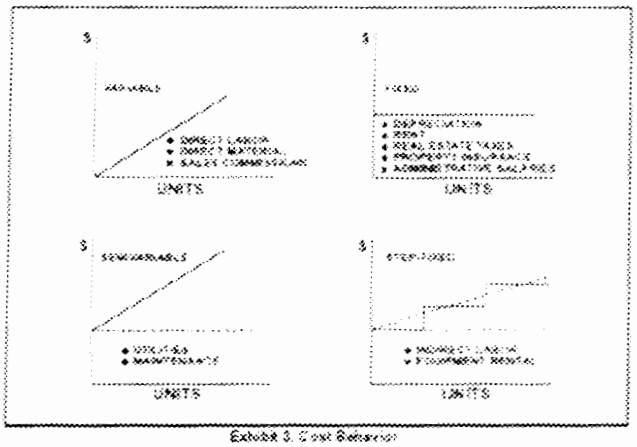


Exhibit 3. Cost Behavior

Indirect Cost Management

NAVIGATING THE SEA OF OVERHEAD

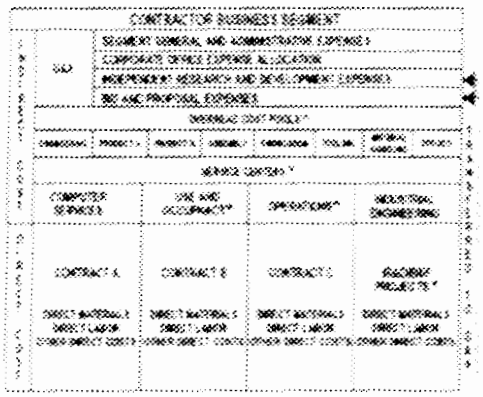
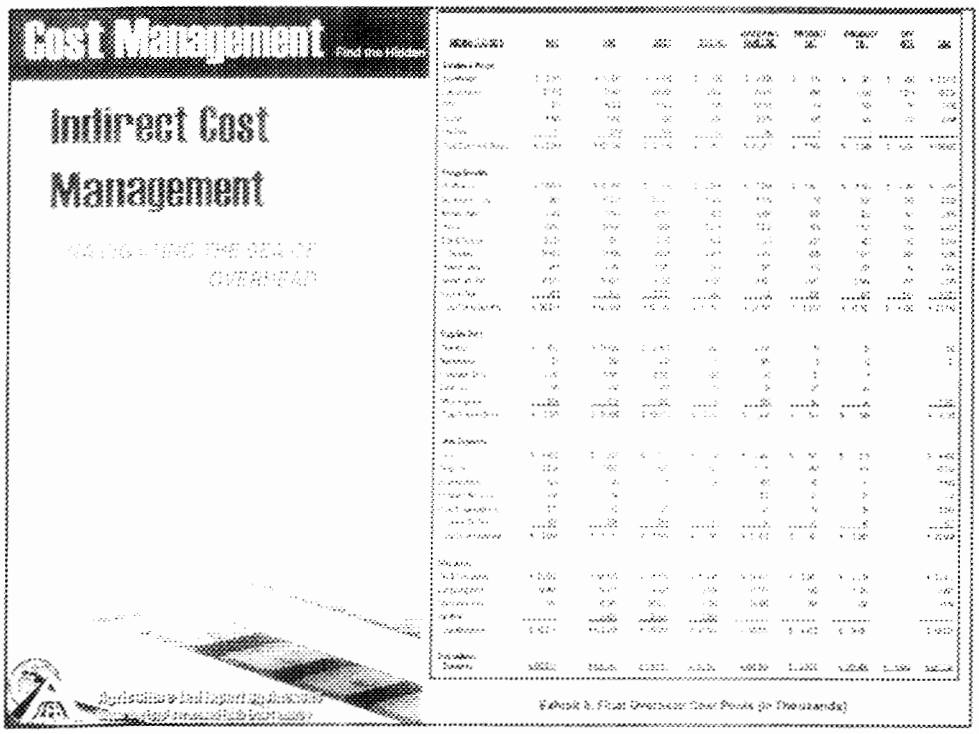
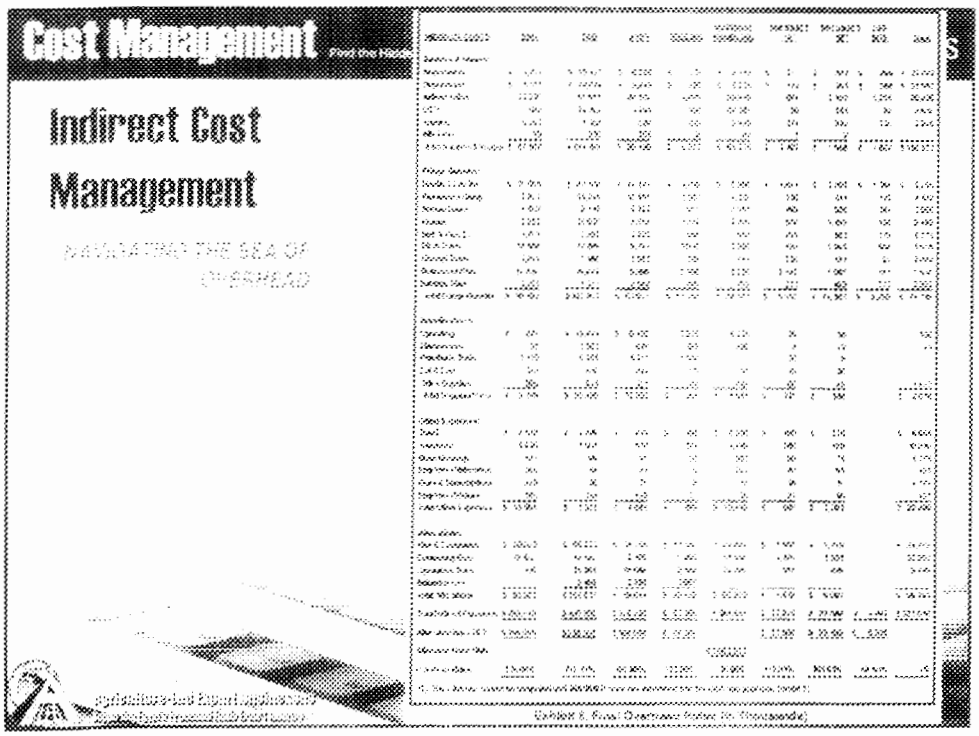
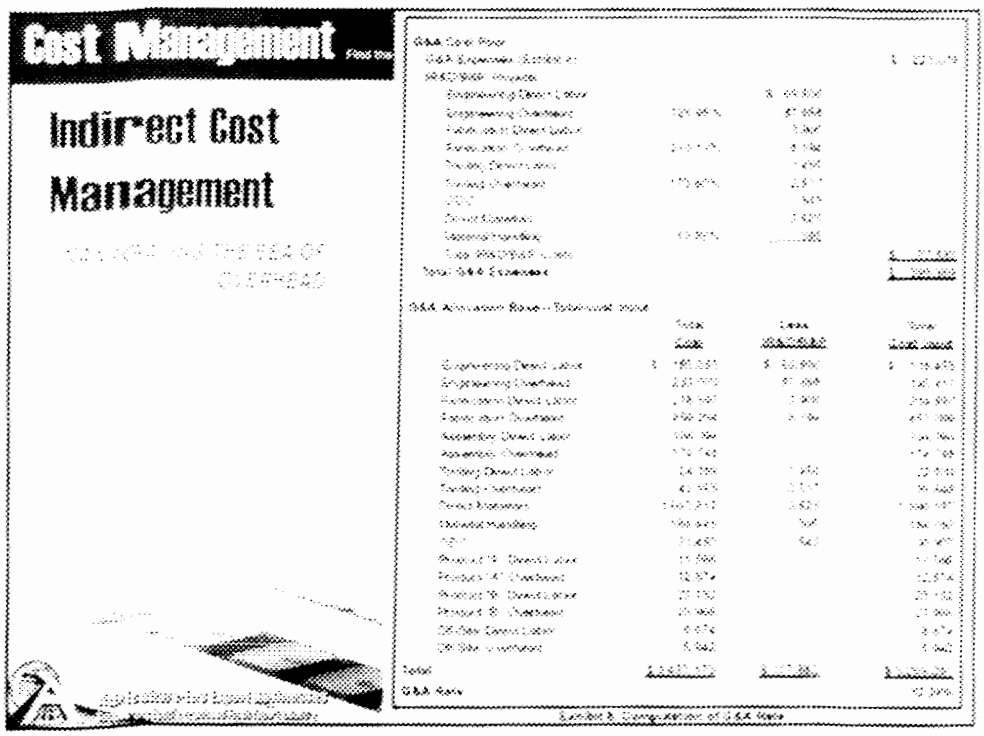
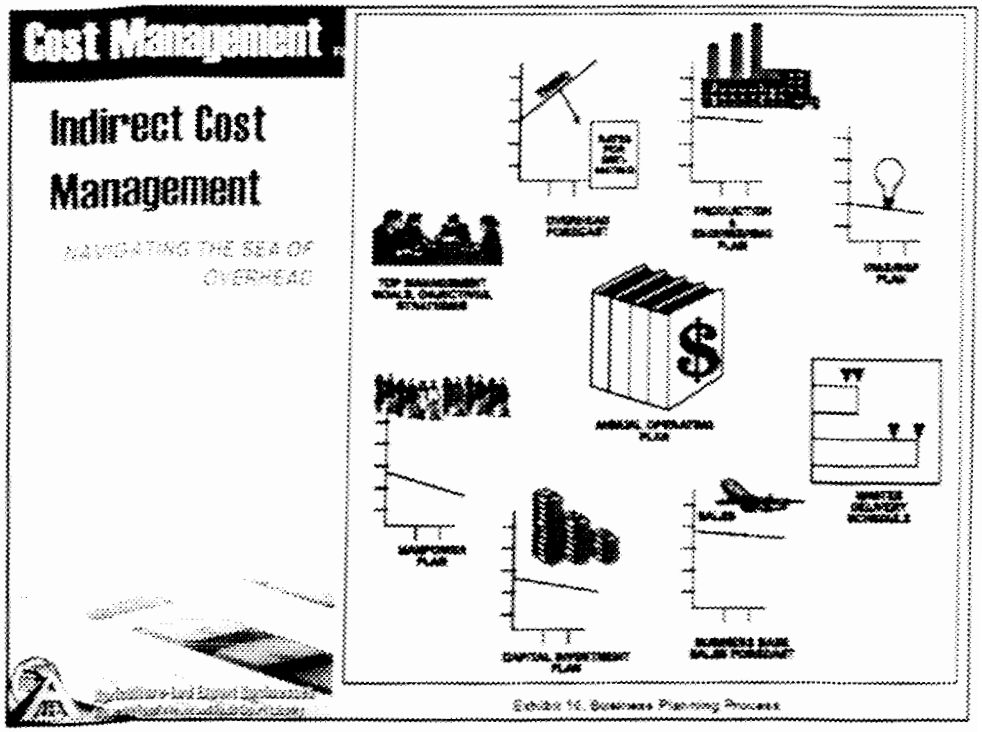


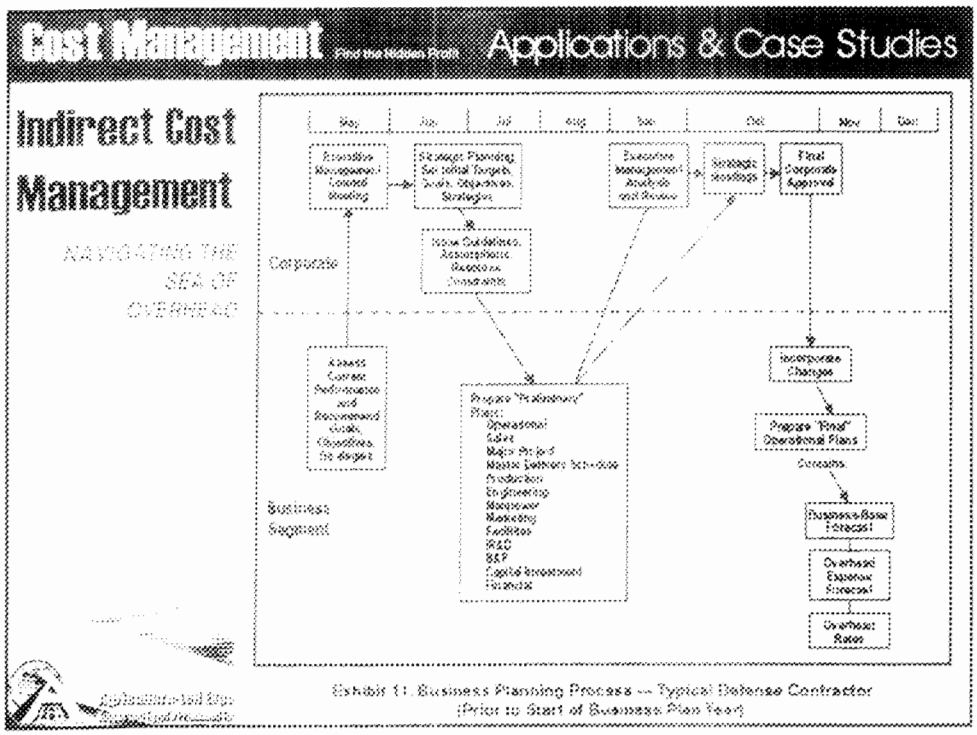
Exhibit 4. Typical Contractor Cost Hierarchy

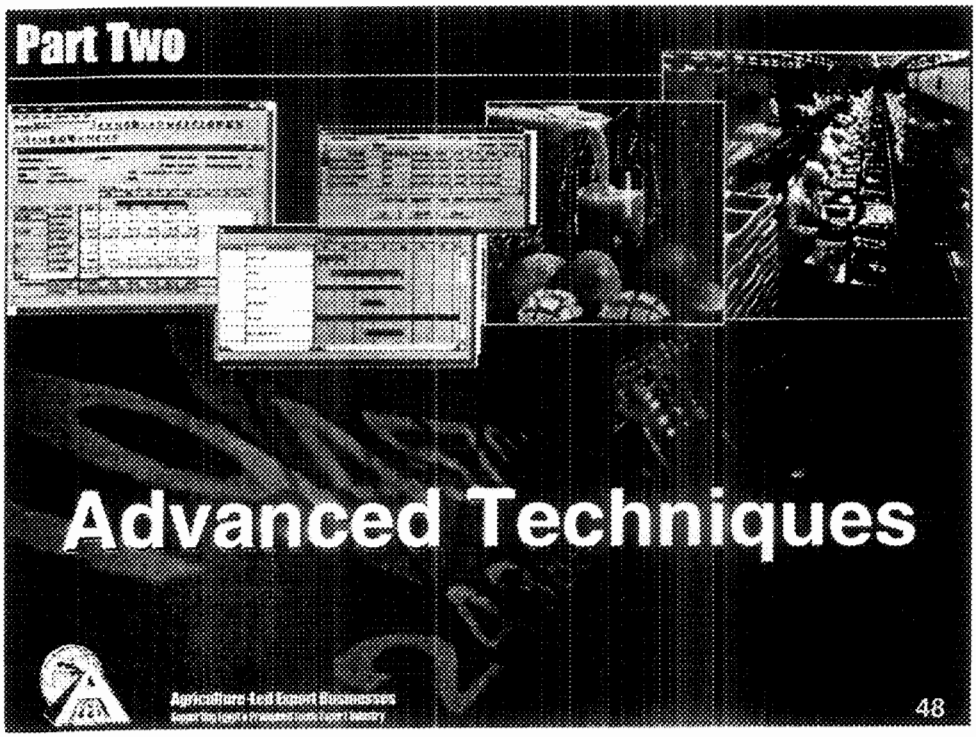

Cost Management
Indirect Cost
Management


Cost Management
Indirect Cost
Management


Cost Management
Indirect Cost
Management


Cost Management
Indirect Cost
Management
NAVIGATING THE SEA OF
OVERHEAD


Cost Management
Applications & Case Studies
Indirect Cost Management
Corporate
Business Segment
Exhibit 11. Business Planning Process — Typical Defense Contractor
(Prior to Start of Business Plan Year)


Part Two
Advanced Techniques
Agriculture-Led Export Businesses
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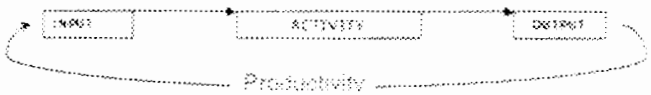
Techniques Process Mapping

What is a Process Map?

A process map describes the way a task is performed. It defines the main activities in completing a task including items used and produced ('deliverables').

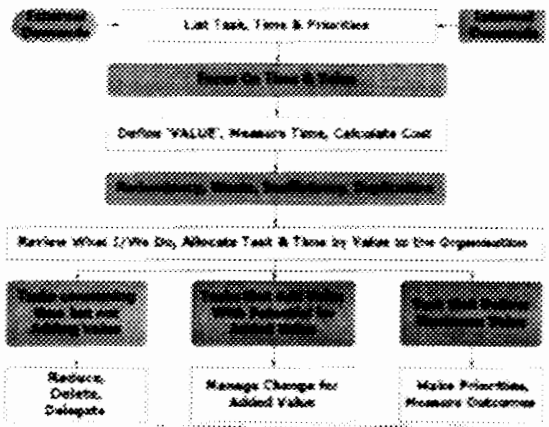


Process maps provide a powerful tool for understanding and communicating how work is performed. They are easier to read and comprehend than alternatives such as procedures manuals. They are also a quicker means to identify what does, and does not add value.

Cost Management Applications & Case Studies

Techniques Process Mapping

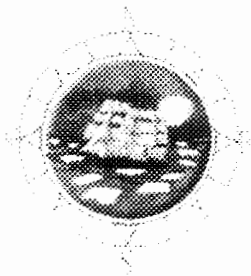
Process maps are increasingly being used in organisations to capture snapshots of day to day working processes. Knowing how you function today is an investment in improving how you function tomorrow - in a strategic, measured and thoughtful way.



Identifying and understanding the steps to convert inputs to outputs produces better processes. It provides insight that enabled staff to contribute to improved processes and [illegible]

Techniques Process Mapping

Process Navigator

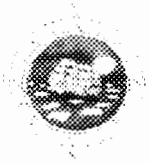


Process Navigator is process mapping software developed by Triaster, in the United Kingdom.

Process Navigator has a user-friendly interface combining rigorous mapping methodology with ease of use. Users generate process maps independently while the Analyst Edition enables further formal analysis using amalgamated maps and integrated information.

Process Navigator assists focussed review. Beneath each node is a sophisticated summarisation of costs, time durations, heath and safety issues, controls, opportunities for improvement and [illegible]

Techniques Staff Driven Improvement



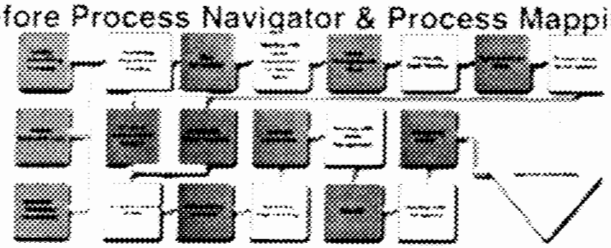
When staff generate their own process maps, they are well placed to drive improvement. The 'ownership' and 'buy in' achieved creates a huge advantage when implementing new ways of working for improved results.

Having thought through (conceptualised) the steps involved in their work (processes) and drawn (mapping) the process, staff use their enhanced understanding to focus on what adds value while deleting anything that doesn't. The result is greater value based on increased insight, informed choice and the motivation to initiate positive change.

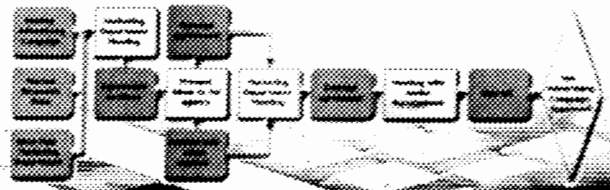
Techniques

Staff Driven Improvement

Before Process Navigator & Process Mapping



After Process Navigator... Why Process Mapping?



Cost Management Applications & Case Studies

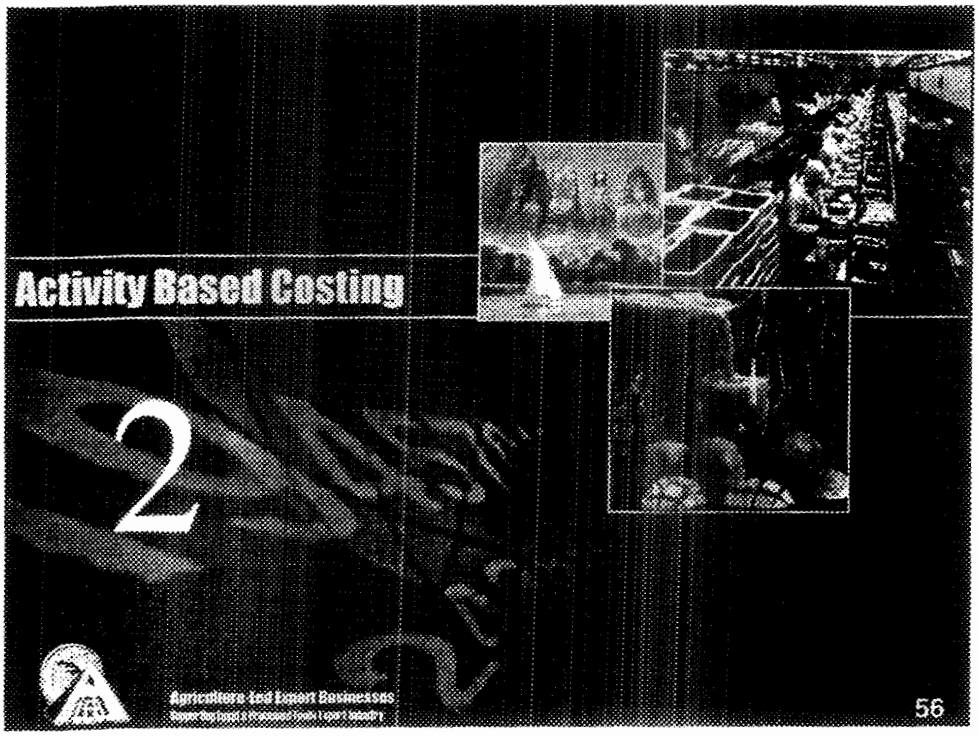
Techniques

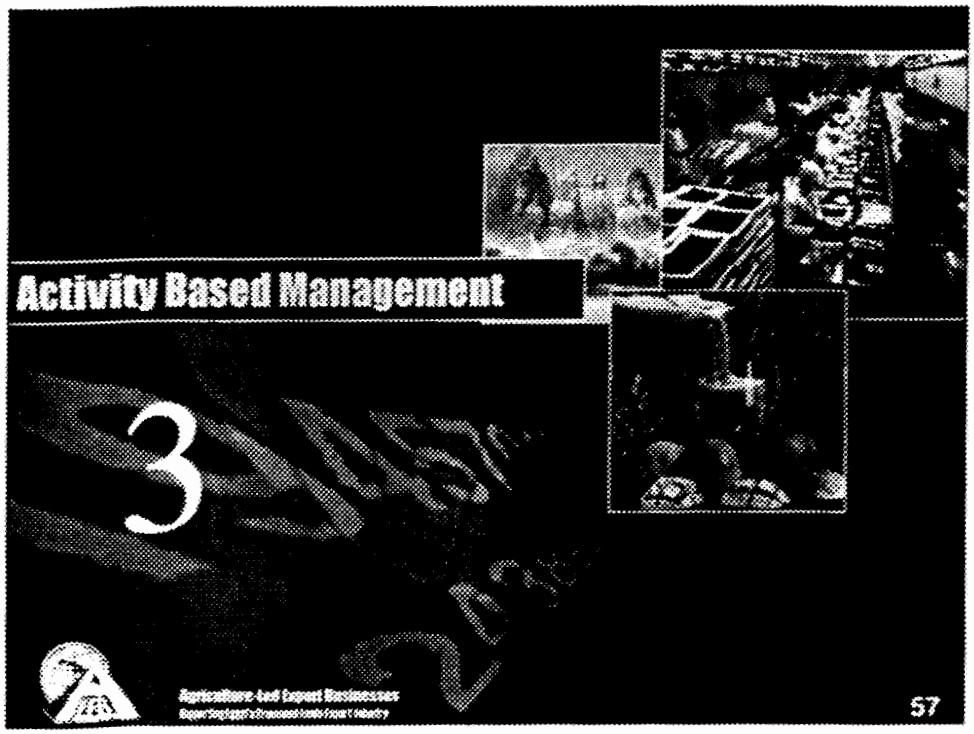
Staff Driven Improvement

In the US in the early 80's Ford used Process Mapping to identify that paper in Accounts Payable was being handled 14 times before any effective action. Having identified the waste and duplication, it was then possible to focus on achieving greater efficiency with outstanding results.

Paper shuffling is seldom conducive to highly motivated staff.

Activity Based Costing
1
Agriculture-Led Export Businesses
55


Activity Based Costing
2
Agriculture-Led Export Businesses
56


Activity Based Management
3
57

1| COST MINIMIZATION

Purposes: To show how a cost minimizing firm chooses inputs in the long-run. To show how to derive a firm's long-run total cost curve.

Computer file: **costmin198.xls**.

Background information:

Consider a firm, say a university, that produces an output, for example, the number of student credit hours, from two inputs, labor, L, and capital, K. The university's provost (chief academic officer) can buy any amounts of the two inputs used in production at fixed, known prices. The problem she faces is to choose the amounts of labor and capital that will minimize the total cost of producing a specified output. In other words, this is the standard cost minimization problem in the theory of the firm.

The production function for the university gives the current technology of production. Given the technology of production, the cost minimizing amounts of the inputs are those for which (i) the firm can produce the required output, and (ii) the marginal rate of technical substitution of labor for capital equals the ratio of the price of labor to the price of capital. Another way to say this is that the university should be on a cost constraint (isocost line) where the constraint is just tangent to the given isoquant.

Once you find the cost minimizing amounts of inputs, you will examine the effects of changing input prices on the university's minimum cost of production, and you will derive the school's long-run total cost curve.

The spreadsheet shows a few of the university's isoquants, and a cost constraint for the current level of output and input use. The baseline value for output is 30, and the baseline values of labor and capital are $9 and $4, respectively. You can return to these values by clicking on the appropriate button on the spreadsheet. Excel computes the amount of capital needed to produce the current output of 30 units of instruction.

Get a feel for how the model works by setting output to 30, and choosing some different values for labor. Notice how the cost of production changes every time you choose a different amount of labor to produce the given output. Notice also that the isocost line (cost constraint) changes every time you change labor to show the effects on total cost.

The central question here is how to produce the required output at minimum total cost. The answer is to choose input amounts that make the Marginal Rate of Technical Substitution of L for K equal to P(L)/P(K). Here's how to use Goal Seek to find the answer.

Set output to its required amount, and make sure input prices are at the amounts you want.

(i) Select the cell containing the current value for the MRTS.
(ii) Enter Goal Seek from the Formula menu.
(iii) Click on the To Value box, and enter the numerical value of the price ratio of the inputs using the keyboard.
(iv) Click on the By Changing Cell box, then click on the cell containing the current value of labor. The cell address should appear in the By Changing Cell box.
(v) Click on OK, and, if everything goes well, Excel will find a solution. To update the worksheet with the solution, click on OK.

The firm's long-run total cost curve shows the minimum cost of producing any output, given input prices and the technology of production, when all inputs are variable. You can find points on the LRTC by solving the firm's cost minimization problem for a succession of output levels, holding input prices constant. That's just what you're asked to do in the problems, and you will plot the LRTC from the points you find.

Here are some things to watch for and learn as you do the problems.

1) At the cost minimizing input choices, the ratio of the input prices (PL/PK) is equal to the MRTS (L for K). The isoquant and cost constraint are tangent to each other.

2) Lowering an input price will lead the firm to use more of the input whose price has fallen.

3) Note the similarity between the cost minimization problem firm's face and the utility maximization problem consumers face.

4) Note that the MRTS of labor for capital is equal to the ratio of marginal product of labor to the marginal product of capital (MP_L/MP_K)

MATH MAVEN'S CORNER: The production function used to generate the graph is given by $Q = AL^{a}K^{\beta}$ where L is the amount of labor and K is the amount of capital. The cost constraint is given by $C = P_L L + P_K K$, where C is total cost, and P_L and P_K are the prices of L and K, respectively. The values of A, a, and β are chosen randomly, but can be seen in the Answer Bin. The math problem is to minimize C subject to the production function with output set to the required output. It can be solved either of two ways: substitute the constraint into the definition of total costs so only one of the inputs is a variable and then minimize, or use the Lagrangian

Theorem. Satisfy yourself, if you wish, that the marginal rate of technical substitution of L for K is $(a/\beta)(K/L)$ in this case. The $MRS_{L \text{ for } K}$ in general is $-dK/dL|_{dQ=0} = (\partial Q/\partial L)/(\partial Q/\partial K)$.

COST MINIMIZATION

Questions

Set output and input prices to their baseline values. Set labor use to 50.

1) What is the total cost of 30 units of output when labor is 50?
2) How much capital is used in this case?

Continuing on from the last question:

3) What is the marginal product of labor?
4) What is the marginal product of capital?
5) What is the MRTS of labor for capital?

Be sure output and input prices are at their baseline values.

6) What is the minimum cost of producing 30 units of output?
7) How much labor is used at the cost minimizing solution?
8) How much capital is used at the cost minimizing solution?

Continuing on from the last question:

9) At the cost minimizing solution, what is the ratio of the price of labor to the price of capital?
10) At the cost minimizing solution, what is the MRTS of L for K?

Set all variables to their baseline values. Questions 11-16 generate the data to find the firm's long-run total cost curve.

11) What's the minimum cost of producing zero units of output?
12) What's the minimum cost of producing 10 units of output?

13) What's the minimum cost of producing 20 units of output?
14) What's the minimum cost of producing 35 units of output?
15) What's the minimum cost of producing 40 units of output?
16) What's the minimum cost of producing 45 units of output

17) Print out the Graph Paper sheet by selecting it (by clicking on its tab at the bottom of the screen), and clicking on the button to print. Graph the firm's total cost curve using the points you found in questions 6 and 11 to 16.

Set all variables to their baseline values. Now raise the price of labor to $12/unit.

18) What's the new minimum cost of producing 30 units of output? (Compare to question 6.)

19) Following on from the last question, what's the new best level of labor use? (Compare to question 7.)

2| MORE COST MINIMIZATION

Purposes: To illustrate cost minimization by emphasizing input marginal products. To show how to derive the firm's total product curves for a single variable input.

Computer file: **costmin298.xls**.

Background information:

Consider again a university that produces student credit hours from two inputs, labor, L, and capital, K. Just as in the previous problem set, the provost faces the standard cost minimization problem – for given technology and input prices, how can total cost be minimized for a given level of production.

The difference here is in the form of the information the provost has about the technology of production, the university's production function. In this problem set she knows directly the marginal products (MP) of the two inputs. She can compute the marginal rate of technical substitution from the marginal productivities, but those data are not displayed on the spreadsheet. Indeed, the MRTS(L for K) is equal to the marginal product of labor (MP_L) divided by the marginal product of capital (MP_K).

This gives us a different, and, to many people, more intuitive explanation of the decision rule for minimizing the cost of production. The decision rule for minimizing cost is to choose inputs so that $MP_L/P_L = MP_K/P_K$. MP_L/P_L, labor's marginal product divided by it's price, is the extra output due to spending another dollar on labor. Costs are minimized when the marginal product per dollar spent on all inputs is the same.

If the marginal product per dollar differs between any two inputs, output can be increased (or cost lowered), buy shifting resources in favor of the input with the *higher* MP per dollar.

In the spreadsheet, you are asked to find the minimum cost following this rule. Use Goal Seek to do this. First set output to the desired amount. Then use Goal Seek to set the *difference* between the marginal products per dollar to zero by changing the amount of labor.

One new exercise here is showing how to find the *short-run total product curve* for a single variable input, given some amount of a fixed input. You're asked to set the capital amount to 60, and find the relationship between output and the single variable input, labor. Doing this for several amounts of labor allows you to find – and plot – the total product curve. In a subsequent exercise you will learn about the relationship between these short-run total product curves and a firm's short-run cost curves.

Here are some things to watch for and learn as you do the problems.

1) At the cost minimizing input choices, the marginal product per dollar spent on labor equals the marginal product per dollar spent on capital. The isoquant and cost constraint are tangent to each other, just as in the previous problem set.

2) You should be able to manage the cost minimization problem both in terms of marginal products, and in terms of the marginal rate of technical substitution.

3) The firm's total product curve is the relationship between output and a single variable input. Be sure you can tell by looking at your graph of the total product curve whether or not the technology obeys the Law of Diminishing Returns.

Here is a trick to help you get answers to questions 9 to 15:

Finding the values of labor and output for a given level of capital can be tricky, because you cannot change the capital amount directly on the spreadsheet. Here's how to proceed:

(i) Set the value for labor to the value called for in the problem.
(ii) Select the cell containing the current value of capital.
(iii) Enter Goal Seek from the Tools menu.
(iii) Click on the To Value box, and enter the numerical value of the capital.
(iv) Click on the By Changing Cell box, then click on the cell containing the current value of output. The cell address should appear in the By Changing Cell box.
(v) Click on OK, and, if everything goes well, Excel will find a solution. To update the worksheet with the solution, click on OK.

MATH MAVEN'S CORNER: The production function used to generate the graph is given by $Q = AL^{\alpha}K^{\beta}$ where L is the amount of labor and K is the amount of capital. The cost constraint is given by $C = P_L L + P_K K$, where C is total cost, and P_L and P_K are the prices of L and K, respectively. The values of A, a, and β are chosen randomly, but can be seen in the Answer Bin. The math problem is to minimize C subject to the production function with output set to the required output. It can be solved either of two ways: substitute the constraint into the definition of total costs so only one of the inputs is a variable and then minimize, or use the Lagrangian Theorem. Satisfy yourself, if you wish, that the marginal rate of technical substitution of L for K is (a/ß)(K/L) in this case. The $MRS_{L\ for\ K}$ in general is $-dK/dL|_{dQ=0} = (\partial Q/\partial L)/(\partial Q/\partial K)$.

COST MINIMIZATION

Questions

Set output and input prices to their baseline values. Set labor use to 40.

1) What is the total cost of 27 units of output when labor is 40?
2) What is the marginal product of labor when output is 27 and labor is 40?

3) Continuing on from the last question, what is the marginal product of capital when labor is 40 and output is 27?
4) Continuing on from the last question, if the firm buys another dollar's worth of labor, by how much does output increase?

5) Continuing on from the last question, if the firm buys another dollar's worth of capital, by how much does output increase?
6) If the firm wants to minimize total cost, should it be using more labor or more capital? (enter labor or capital).

7) Continuing on from the last question, what's the best level of labor to use to produce 27 units of output?
8) What are total costs at the best amount of labor (and capital)?

Set all variables to their baseline values. Now suppose the firm is operating in the short-run with fixed capital of 60 units.

9) For capital equal 60, and labor equal to 1, what is output?

Continuing on from the last question:

10) For capital equal to 60, and labor equal to 5, what is output?
11) For capital equal to 60, and labor equal to 10, what is output?
12) For capital equal to 60, and labor equal to 20, what is output?

Continuing on from the last question:

13) For capital equal to 60, and labor equal to 30, what is output?
14) For capital equal to 60, and labor equal to 40, what is output?
15) For capital equal to 60, and labor equal to 50, what is output?

Print out the Graph Paper sheet by selecting it clicking on the print button.

16) Use the data you generated answering questions 9 through 15 to plot the total product curve for the firm as a function of labor.

3| MARGINAL PRODUCTS AND MINIMIZING COST

Purpose: To illustrate cost minimization using marginal products directly, rather than the idea of marginal rate of technical substitution.

Computer file: **costmin398.xls**

Background information:

This problem set takes a different tack to understanding cost minimization for a given level of output. Instead of relying on the difficult idea (at least for people who don't know calculus) of the marginal rate of technical substitution, we consider the rule for cost minimization rewritten so that it emphasizes the marginal products of inputs, and the notion of marginal product per dollar.

Regardless of one's technical background, many people find the intuition in the approach taken in this problem set to be more accessible.

Again take a typical firm that wants to minimize the total cost of producing a particular level of output. The firm uses two inputs, labor and capital, that can be bought at fixed prices P(L) and P(K). We can find (for any amounts of the inputs) the *marginal product* of, say, L as the increase in output achieved from employing an extra unit of labor, holding capital constant. The *marginal product per dollar* spent on labor is therefore MP(L)/P(L). This is the increase in output the firm can achieve from spending another dollar on labor. Similar definitions hold for capital.

A firm wanting to minimize cost should always seek a mix of inputs, L and K, such the the marginal products per dollar spent on each should be equal. That is, we want MP(L)/P(L) = MP(K)/P(K). Why? Suppose the firm is producing the desired output with MP(L)/P(L) > MP(K)/P(K). Spending one dollar less on capital will reduce output by capital's marginal product per dollar. But because the marginal product per dollar for labor is greater than that for capital, less than a dollar's worth of labor must be bought to achieve the desired output. Costs are reduced by buying more of the input whose marginal product is higher.

The graph in this problem set displays directly the marginal products per dollar for each input. You can determine by simple inspection of the height of the graphs whether cost if minimized, and if not, which input should be more intensively employed.

To find the cost minimizing amounts of labor and capital, use Goal Seek to make the difference between their marginal products per dollar equal to zero by changing the amount of labor.

MATH MAVEN'S CORNER: The production function used to generate the graph in this problem set is the same exponential form given by $Q = AL^{\alpha}K^{\beta}$ where L is the amount of labor used and K is the amount of capital used. Once again the actual values for the parameters appear in the Answer Bin, and you can use them to answer the questions by more conventional means – pencil, paper, and a hand calculator.

MARGINAL PRODUCTS AND MINIMIZING COST

Questions

Set output and input prices to their baseline values. Set labor use to 12.

1) What is the total cost of 23 units of output when labor is 12?
2) What is the marginal product of labor when output is 23 and labor is 12?

3) Continuing on from the last question, what is the marginal product of capital when labor is 12 and output is 23?
4) Continuing on from the last question, if the firm buys another dollar's worth of labor, by how much would output increase?

5) Continuing on from the last question, if the firm buys another dollar's worth of capital, by how much does output increase?
6) If the firm wants to minimize total cost, should it be using more labor or more capital? (enter labor or capital).

7) Continuing on from the last question, what's the best level of labor to use to produce 23 units of output?
8) What are total costs at the best amount of labor (and capital)?

Set all variables to their baseline values, and find the best amounts of labor and capital to produce 20 units of output.

9) What is the cost minimizing amount of labor?

Continuing on from the last question, now lower the price of labor to $5.

10) Which input now has the higher marginal product per dollar? (labor or capital)
11) What's the new cost minimizing amount of labor?

4 TOTAL, AVERAGE, AND MARGINAL COSTS

Purpose: To illustrate the relationship between total, average and marginal costs. To show the effects of changes in fixed costs and of per unit (excise) taxes.

Computer file: **tamc98.xls**

Instructions and background information:

You operate the Smiling Dog Vineyard and Winery in Paw Paw, Michigan. The top graph shows the short-run total cost curve for the production of wine. Quantity is the number of cases you produce each year. Total costs are measured on the vertical axis. The base value for fixed cost is $25,000, and the amount of tax on your output is zero. When you change either fixed cost or the tax the new total cost curve is drawn in the upper diagram.

The bottom graph shows the average and marginal cost curves that correspond to the base case. When you change the level of fixed costs or the tax, Excel draws the new corresponding average and marginal cost curves. When you choose an output level Excel computes and shows the corresponding levels of total, average, and marginal cost.

In both diagrams, output is the independent variable and costs are the dependent variables. You choose a value for output, and the corresponding cost curve shows the value for costs. In the spreadsheet, you can choose Output, Fixed Cost, and the Tax per unit of output. Excel then computes the new total, average, and marginal costs, and redraws the cost curves.

Here are some things to watch for and learn as you do the problems:

1) The shape and position of the average and marginal cost curves is completely determined by the total cost curve. All information relating output to costs is contained either in the total cost curve or in the companion set of average and marginal cost curves. Which representation of costs economists use depends on the particular questions that must be answered.

2) Average and marginal cost curves have a special geometric relationship that is clearly shown in this problem set. When average cost is declining as output increases, marginal cost is less than average cost. When average cost is rising, marginal cost is greater than average cost. When average cost is neither rising nor falling (at a minimum or maximum), marginal cost equals average cost.

3) Marginal cost can be thought of as the cost of one more unit of output. It is the slope of the total cost curve ($\Delta TC/\Delta Q$). It is easy to deduce the general shape of the marginal cost curve by inspecting the total cost curve. In this problem set the total cost curve increases at an increasing rate, so marginal cost rises with output.

4) An excise (per unit) tax raises both average and marginal costs by exactly the amount of the tax per unit. Total cost increases by the output times the tax per unit. One consequence of this is that the output at which average cost is minimized is unchanged if an excise tax is imposed.

5) An increase in fixed costs raises total cost by precisely the amount of the increase. An increase in fixed costs raises average costs, but leaves marginal costs *unchanged*. This last result follows directly from the nature of an increase in fixed costs. The increase shifts the total cost curve upward, but leaves its slope the same at each output.

Here are some hints to help you get the answers quicker:

1) At the minimum average cost, marginal cost equals average cost. The spreadsheet shows a value for the difference between average and marginal costs. You can use Goal Seek or experimentation to find the output that makes this difference equal to zero, that is, the output where average cost is minimized.

2) For letter or word answers to some of the questions, be sure to use lower case letters only. Or search the Answer Bin for correct options.

MATH MAVEN'S CORNER: The total cost curve in the problem is given by

$$TC = FC + a(Q) + b(Q^2) + t(Q)$$

where TC is total cost, FC is fixed cost, Q is output, and t is the tax per unit of output. The values of the parameters a and b are chosen randomly. The average cost is TC/Q, and marginal cost is $\partial(TC)/\partial Q$.

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TOTAL, AVERAGE, AND MARGINAL COSTS

Questions

Set all variables to their baseline values.

1) When average cost is declining, is marginal cost GREATER than, LESS than, or EQUAL to average cost?

Set all variables to their baseline values.

2) When average cost is increasing, is marginal cost GREATER than, LESS than, or EQUAL to average cost?

Set all variables to their baseline values, and set output 4,000.

3) What's the value of average cost?
4) Is AC rising at that output? [yes or no]
5) What is marginal cost when output is 4,000?

Set all variables to their baseline values, and set output to 1500.

6) What's the value of average cost?
7) Is AC rising at that output? [yes or no]
8) What is marginal cost when output is 1500?

Set all variables to their baseline values.

9) At what level of output is average cost a minimum?
10) What is average cost (AC) at that output?
11) What is marginal cost (MC) at that output?

Set the value of the per unit tax to $10.

12) If output is 4,000, how much did AC increase?
13) If output is 4,000, how much did MC increase?
14) If output is 4,000, how much did total cost increase?

Set the tax at $10 per unit of output.

15) At what output is the value for the new AC at its minimum?

Set all variables to their baseline values. Now increase the level of fixed cost to $50,000.

16) If output is 4,000, how much did AC increase?
17) If output is 4,000, how much did MC increase?
18) If output is 4,000, how much did total cost increase?

Set the level of fixed cost to $50,000.

19) At what output is the value for the new AC at its minimum?

20) Which option best describes the effect of increasing a per unit tax? [enter a, b, or c]
   a) AC rises by the amount of the tax per unit.
   b) TC rises by the amount of the tax per unit.
   c) MC is unchanged.

21) Which option best describes the effect of increasing fixed cost? [enter a, b, or c]
   a) TC increases by FC times output.
   b) AC increases by the amount of FC.
   c) MC is unchanged.

5| PRODUCTION AND COST IN THE SHORT-RUN

Purpose: To illustrate the relationship between total product curves and total cost curves. To show the relationship between changes in input prices and a firm's cost of production in the short-run.

Computer file: **tptc198.xls**

Instructions and background information:

You own and operate an apartment cleaning service firm in Detroit. Your business is to clean and repair apartments for landlords whose tenants have recently moved out. The left graph in the computer display shows the total product curve for your firm. The input is the number of workers you hire per day, and the output is the number of apartments cleaned per day.

There are two baseline variables in this problem. One is the wage rate you must pay your workers, and the other is something called "labor efficiency".

Labor efficiency is an index of how efficiently labor services are used to clean apartments, and is an aspect of the technology of production. It doesn't have anything to do with whether you are a good manager, or whether your workers goof off on the job. The relationship between the numbers of employees you hire and the output produced is purely technical. Labor efficiency is .50 in this problem, and you cannot change it -- that is reserved for the next problem set. In the real world, the labor efficiency index might go up if you provide your workers with more equipment -- mops and brooms, for example.

Workers for your business do not come free. In fact, you must hire workers and pay them at a rate of $10 per worker per day. $10/day is the market wage. If you try to pay less than that, workers simply will not work for you.

The data on the total product curve (see the left graph) shows the output you get for any amount of labor input you choose.

The data on the total cost curve show total cost for any output you choose, given the wage rate. You can pick any values you want for output and the wage rate, and the total cost curve on the right displays the results. The table also shows the amount of labor required for the output you choose. The left and right graphs operate independently. The input and output you see in the total product curve can be different from the output and cost you see on the total cost curve.

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Here are some things to watch for and learn as you do the problems:

1) Given the technology of production, you can't get more output without using more labor input.

2) Given the wage rate and the technology of production, higher output is possible only with increased costs.

3) Raising the wage rate (the price of a variable input) increases total, average, and marginal costs. An increase in the wage causes total cost to increase more at higher outputs than lower outputs.

4) In the short-run, fixed costs are the firm's costs when output is zero.

Here are some hints to help you get the answers quicker:

1) Average cost is total cost divided by output.

2) Marginal cost is the change in total cost per unit change in output. $\Delta C/\Delta Q$. Marginal cost is the "cost of one more", the extra cost of increasing output by one unit. The marginal cost of the 25th unit of output is the difference in total cost at 25 minus the total cost at 24 units of output.

MATH MAVEN'S CORNER: The total product curve for the computer problems is $Q = AL^e$, where the exponent e is the efficiency index, and A is a constant. e in this case is also the elasticity of output with respect to changes in L. The marginal product is the derivative of total product with respect to L, or AeL^{e-1}. The total cost curve is $TC = FC + (p_L)(Q/A)^{1/e}$, where p_L is the wage rate, $10.00 a day to start off with.

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PRODUCTION AND COST IN THE SHORT-RUN

Questions

Set all variables to their baseline values, and set labor input to 10.

1) How many apartments are cleaned per day with this amount of labor?

Set all variables to their baseline values, and set labor input to 20.

2) How many apartments are cleaned per day with this amount of labor?

Set all variables to their baseline values, and set labor input to 20. Increase the wage rate to $12/day.

3) With labor at 20, what is the change in output?

Set the wage is $10/day.

4) If 15 apartments must be cleaned, how many workers must be hired to get the job done?

Make sure the wage is set to $10/day, and set output at 15 apartments per day.

5) What's the TOTAL COST of cleaning 15 apartments?

Now set the wage to $12/day.

6) What's the TOTAL COST of cleaning 15 apartments?

7) When the wage rose from $10 to $12 per day, did total cost INCREASE or DECREASE?

Set all variables to their baseline values and set output at 15 apartments per day.

8) What's the AVERAGE COST of cleaning 15 apartments?

Now set the wage to $12/day.

9) What's the AVERAGE COST of cleaning 15 apartments?

10) When the wage rose from $10 to $12 per day, did average cost INCREASE or DECREASE?

Set the wage back to $10/day, its baseline value.

11) What's the MARGINAL COST of cleaning the 15th apartment?
[Hint: What's the total cost of cleaning 15compared to 14?]

Now set the wage to $12 per day.

12) What's the MARGINAL COST of cleaning the 15th apartment at the higher wage?

13) When the wage rose from $10 to $12 per day, did marginal cost INCREASE or DECREASE?

14) What's the amount of fixed cost for the firm?

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6 MORE PRODUCTION AND COST IN THE SHORT-RUN

Purpose: To illustrate the relationship between changes in technology and a firm's cost of production in the short-run.

Computer file: **tptc298.xls**

Instructions and background information:

You own and operate an apartment cleaning service firm in Detroit. Your business is to clean and repair apartments for landlords whose tenants have recently moved out. The left graph shows the total product curve for your firm. The input is the number of workers you hire per day, and the output is the number of apartments cleaned per day.

Just as in the last problem set, the value called "Labor efficiency (new)" is an index of how efficiently labor services are used to clean apartments. Labor efficiency here is part of the technology of production.

The baseline value for "labor efficiency" is .50. You can experiment with what happens to the total product curve for different values for the index. Technological improvements mean an increase in the labor efficiency index, as you can verify with a little experimentation. Notice that an improvement in technology allows you to get more output from the same amount of inputs, and allows you to produce the same level of output at lower cost because you'll need fewer workers.

The figure at the right of the screen shows the short-run total cost curve for your apartment cleaning business. The daily wage you must pay is $10.00, and there are fixed costs, mostly in the form of rental contracts on machinery, and insurance. Under the "TOTAL COST CURVE" information you can select a value for output, and Excel computes the total cost needed to produce that output in the short-run. Notice that under the "TOTAL COST CURVE" information Excel also computes the labor required to produce the output you desire.

You can change the labor use in the left diagram and the level of output in the right diagram independently. Experiment with changing output and the efficiency index until you understand how each kind of change affects the display.

Here are some things to watch for and learn as you do the problems:

1) A change in technology changes the total product curve and and the total cost curve. An improvement in technology *increases* the output you get from a given amount of labor, and *decreases* the cost of producing a given level of output.

2) It is no accident that the total product curves and total cost curves are logically linked. In this example, the total product curve increases at a decreasing rate (the marginal product of labor diminishes as more labor is used), and the total cost curve increases at an increasing rate (the marginal cost rises as more output is produced).

Here are some hints to help you get the answers quicker:

1) Word answers (as opposed to numbers) must be entered as lower case.

2) Average cost is total cost divided by output.

3) Marginal cost is the change in total cost per unit change in output. In economists' jargon, the "marginal cost of the 10th unit of output" is the increase in total cost in going from 9 to 10 units of output.

MATH MAVEN'S CORNER: The total product curve in this problem is the same functional form as the previous problem set.

MORE PRODUCTION AND COST IN THE SHORT-RUN

Questions

Set efficiency to the baseline value of .50.

1) How many apartments can you clean per day with 20 workers?

Keep efficiency at its baseline value.

2) Does the production function (total product curve) have the property of diminishing marginal product? [yes or no]

Increase efficiency to .60.

3) How many apartments can you now clean per day with 20 workers?

Keep the efficiency index at .60.

4) Does the production function (total product curve) still have the property of diminishing marginal product? [yes or no]

Set the efficiency index to its baseline value.

5) What's the TOTAL COST of cleaning 15 apartments?
6) What are the labor requirements for cleaning 15 apartments per day?

Now set the efficiency index to .60.

7) What's the TOTAL COST of cleaning 15 apartments?
8) What are the labor requirements for cleaning 15 apartments per day?

Set efficiency to its baseline value of .50.

9) What's the AVERAGE COST of cleaning 15 apartments?

Increase the efficiency index to .60.

10) What's the AVERAGE COST of cleaning 15 apartments?

Set the efficiency index to its baseline value.

11) What's the MARGINAL COST of cleaning the 15th apartment?

Now set the efficiency index to .60.

12) What's the MARGINAL COST of cleaning the 15th apartment?

You can summarize your results now. For each cost concept listed, does an improvement in efficiency cause an INCREASE or a DECREASE in cost?

13) Total cost.
14) Average cost.
15) Marginal cost.

DISCOUNTED PRESENT VALUE

Purpose: To illustrate the idea of discounted present value with computations of the value of payments to be received in the future at different rates of interest. To use discounted present value to determine the profitability of investments.

Computer file: **pv98.xls**

Instructions and background information:

The spreadsheet for this problem set is a kind of calculator that will help you compute the discounted present value of a series of payments and costs.

The first three spreadsheet columns show information on payments and costs associated with an asset in several years. The relationship upon which all the calculations are based is that the present value of P(t) dollars to be received t years hence is equal to $[P(t)/(1+i)^t]$, where i is the rate of interest expressed as a decimal.

Column A lists the years payments are to be received or costs incurred. Year 0 is today, year 1 is one year from today (one year hence, in economist's jargon), etc.

Column B shows the amounts of payments (in dollars) received by the owner of a hypothetical asset in respective years. On "wake up" this column has $100 in rows 3 through 7. You can enter any numbers you wish in this column. Hitting the "Reset to Baseline" button will clear the values from this column.

Each entry in column C shows the discounted present value (DPV) of the payment just to the left in column B. E.g., the DPV of $100.00 to be received 4 years in the future if the interest rate is 6% is $79.21 [cell C7]. [$79.21 = $100/((1 + .06)^2)] In economist's lingo this is called "The present value of $100 four years hence at 6 percent."

Cell E3 shows the current interest rate. On "wake up" i = .06 or 6%. To change the interest rate, select cell E3 and enter the rate of interest either as a percent or a decimal. For example, to change the interest rate to 10 percent, enter either .10 or 10%.

Many assets, and the one shown is an example, give the owner a series of payments in many years in the future, not just a single payment. Cell F3 shows the discounted present value of the series of payments in column B. That is, it is the sum of the values in column C. The value in cell F3 is the present value of the asset.

The graph is a bar chart showing the present value of each of the payments in the respective years. You should experiment by choosing some different values for the payments and/or inserting new ones, and seeing what happens to the present values in the graph. You should also experiment by choosing some different values for the rate of interest. Be sure you understand why an increase in the rate of interest must decrease the present value of a payment to be received in the future.

Here are some things to watch for and learn as you do the problems:

1) For a payment to be received in the future there is an inverse relationship between the rate of interest and the present value of the payment. Higher interest rates always lead to lower discounted values.

2) You should buy an asset if the discounted present value of the benefits (payments) is greater than the discounted present value of the costs.

3) The DPV of an asset is the amount of money you would have to put on deposit (lend) today at the current interest rate to be able to withdraw (receive) the payments in the future.

Here are some hints to help you get the answers quicker:

1) In these problems all future payments and costs are assumed to take place at the *end* of the period in question. For example, in question 1, enter the value of the payment in cell B6, next to year 3. In question 5, enter the first interest payment from the bond next to year 1. The payment for year 0 should be blank.

2) In question 5, enter the first interest payment from the bond next to year 1. The payment for year 0 should be blank.

3) In question 7, the first return from owning the machine occurs in year 1, that is, *after* one year. However, the cost of the machine occurs today, year 0. In all, you get 6 years of returns from owning the machine. Remember to add the scrap value of the machine to the returns in last year.

4) In question 17 you get the payoff from the first year of energy saving in year 1. (Year 0 should be blank or zero.) Then enter $40 through year 10.

Try this exercise to get some insight into the value of your college education.

Suppose you are considering buying a college education (majoring in Economics?) which you expect to give you considerably higher incomes in future years than if you had just a high school education. Your income is expected to be

$15,000 per year higher with the college education. Your working life will start 3 years from now, say, and last for 40 years.

What is the value of the *returns* to the college education if interest rates are 3%, 6%, and 10%?

What's your own personal estimate of the *cost* of your college education? Assume a 4 year college career. Add a) and b) together, discounting the future costs if you wish to get the total cost.

a) Opportunity cost in lost wages.

b) Out of pocket costs of tuition, books, supplies, etc. (but not housing or meals).

Is the investment going to be worth it?

DISCOUNTED PRESENT VALUE

Questions

Note: The values of payments and costs you need to answer the questions are generated randomly by the spreadsheet when you open it. You will need to look at the questions in the spreadsheet to obtain the values.

Your Uncle Harry says he will give you $_____ three years from now to help you pay for a new car.

1) When the interest rate is 6%, what's the present value of his gift to you?
2) What's the present value if the rate of interest is 3%?

3A) Some people set up trusts or make other financial arrangements to pay for their kid's college education. Martha Klutz knows that when her daughter goes to college the expenses will be $_____ per year for four years. [Go on to 3B.]

Her daughter is now a high school sophomore, so the first bill will arrive 3 years from now. The rate of interest is 8%.

3B) How large a trust must Klutz set up today so that her daughter's college education is just paid for in the future?

4) How large would the trust have to be if the rate of interest was 3% instead of 8%?

5A) A bond is a promise to pay its holder fixed amounts of money at specified times in the future. Suppose you have a chance to buy a bond that pays the following amounts in interest and principal: [Go on to 5B.]

5B) After one year you will receive a series of annual interest payments of $_____ for 10 years. At the time you receive the last interest payment you will receive the principal value of the bond of $20,000. [Go on to 5C.]

5C) If the rate of interest is 7%, what's the maximum amount you would be willing to pay for the bond?

6) If the rate of interest were 10%, what would be the price of the bond?

7A) You are in the pizza business and want to buy a new pizza making machine. The machine costs $_____ today. At the end of each year you own the machine it will give you returns of $_____ after paying for maintenance and repairs. [Go on to 7B.]

After you have owned the machine for 6 years you expect to sell it for scrap for $1,000. (You scrap it at the same time you get the last $_____ return.) What is the present value of the RETURNS at

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7B) 3%?
8) 7%?
9) 11%?

What's the present value of the COST of the machine if the interest rate is:

10) 3%?
11) 7%?
12) 11%?

Should you buy the machine at each of the following interest rates? [Enter Yes or No.]

13) 3%?
14) 7%?
15) 11%?

16A) You win a big prize in the Super Lottery. You receive $_____ today, and then $_____ for each of the succeeding 9 years. [Go on to 16B.]

16B) How much would the state have to put on deposit today to just pay you off if the state's interest rate is 7%?

17A) You go to Big George's to buy a new refrigerator for your apartment. The store offers two models, regular (costs $_____) and energy efficient (costs $_____). Both will last for 10 years. [Go on to 17B.]

The energy efficient refrigerator will save you $40 per year in electricity bills.

17B) What's the difference in the initial purchase price between the energy efficient model and the regular model?

Continuing on from the previous question assume the rate of interest is 12%.

18) What's the present value of the energy saving from the energy efficient model?
19) Should you buy the energy efficient model? [Yes or No]

INTERNAL RATE OF RETURN

Purpose: To illustrate how to compute the internal rate of return on an investment or series of future payments and costs. To show how to use the internal rate of return to make investment decisions.

Computer files: **irr98.xls**

Instructions and background information:

The first two spreadsheet columns show information on payments and costs associated with an asset in several years.

Column A lists the years payments are received or costs incurred. Year 0 is today, year 1 is one year from today, etc. Column B shows the dollar payments received or costs incurred on a hypothetical asset in respective years. On "wake up" this column has -9500, 500, 500, and 10500 in the topmost cells. Costs are entered as negative numbers, so the asset represented is one that costs $9,500 today and pays $500, $500, and $10,500 in each of the next 3 years, successively.

Cell D58 shows the internal rate of return (IRR) on the asset whose cash flow values are listed in the cells in column B. The IRR is the interest rate that makes the sum of the present values of the payments equal to zero. If i is a rate of interest, the IRR is the value of i that makes this equation true:

$$0 = R(0) + R(1)/(1+i) + R(2)/(1+i)^2 + \ldots + R(T)/(1+i)^T,$$

where R(t) is the dollar return t years from now.

Another way to define the internal rate of return is as the interest rate that makes the net discounted present value of an asset equal to zero. Or, equivalently, as the interest rate that makes the discounted present value of the costs equal to the discounted present value of the returns. All of these ways of saying it come down to the same thing.

Of course, solving the equation for the internal rate of return may not be an easy task. In fact, for T larger than 5 there is, in general, no way to do it using the ordinary methods of algebra, so various methods of approximation are used. Excel finds the IRR by trial and error, and the way the computer you are working on is set up, it gives up if it doesn't get close to the answer after 20 tries.

To help Excel out, you can choose a value in cell F58, labeled BEST GUESS. It is the interest rate Excel starts with as it tries to find the IRR by trial and error. When the spreadsheet wakes up the BEST GUESS for the internal rate of return is 10%.

You can change BEST GUESS and all of the values in column B to answer the questions. All other cells in the sheet are locked.

The graph shows the net discounted present value of the asset you are working with at interest rates from 0 to 100 percent in 1 percent intervals. The internal rate of return can be estimated by seeing where the graph crosses zero on the vertical axis. You can use the graph to make a good BEST GUESS.

Experiment with some different values for returns and costs in different years and see what happens to the internal rate of return.

NOTE: The numbers in column B must contain at least one positive value and one negative value for the procedure to work. In addition, Excel has a quirk in the IRR computation that makes it treat blanks and zeros differently. If you want a zero payment or cost in an intermediate year of your asset, be sure to enter "0" in the cell, don't just leave it blank.

Here are some things to watch for and learn as you do the problems:

1) The answers to questions 1, 3, 4, and 8 are percentages -- rates of return. Enter your answer in the answer sheet either as a decimal, or with a percent sign (%). For example, if your answer is 7.52 percent, enter either .0752 or 7.52%.

2) The IRR is the average annual rate of return on an asset.

3) Generally, you can profit by buying assets that have an IRR greater than the rate of interest you have to pay to borrow money. The idea is that if IRR exceeds the rate of interest you can use the income from the asset to pay off both principal and interest from the loan and still have something left over.

4) Higher internal rates of return occur when costs go down or returns rise.

Here are some hints to help you get the answers quicker:

1) In question 3, remember to deduct the $3,000 down payment from the cost of the car. Enter the loan amount as a negative number in cell B58. Then enter the 5 payments you must make in succeeding years.

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2) Question 4 is very much like Question 7 in the problem set on discounted present value. Remember to add the scrap value of the machine to the last return that you enter in year 7.

3) In Question 8 on the lottery, you sell the winning ticket to someone else. That means the buyer's return in period zero is a negative amount that is the payment to you, plus the immediate payment when the ticket is cashed. The remaining 9 payments are entered as positive numbers.

Try this exercise to get an idea how economists use the IRR to measure the value of a college education.

Suppose your sister or brother is about to finish high school and is considering buying a college education (majoring in Economics?) which he/she expects to yield considerably higher incomes in future years than if he/she had just a high school education. Income will be $18,000 per year higher with the college education. If your sibling goes to college, his/her working life will start 5 years from now, say, and last for 40 years. Suppose the costs in each of the 4 years of college are $12000. The first year of costs occurs one year from now, so enter it next to Year 1. And remember to put a minus sign in front of the costs. Then enter the remaining costs and benefits next to the correct years. (The last income payment should be entered in year 44.)

What is the internal rate of return on a college education for your sibling?

In the computer exercise on discounted present value you gave an estimate of your real life estimated costs of your college education. Divide that total cost by 4 to get the estimated annual cost, and enter the costs in the spreadsheet. What is the expected internal rate of return on your investment if the annual income gain estimates of $15,000 per year for 40 years are correct?

INTERNAL RATE OF RETURN

Questions

Note: The values of payments and costs you need to answer the questions are generated randomly by the spreadsheet when you open it. You will need to look at the questions in the spreadsheet to obtain the values.

1A) A government bond costs $_____ today, and will pay you $_____ in interest in each of the next 3 years. The first payment occurs one year from now. [Go on to 1B.]

At the time you receive the last interest payment you also receive the bond's principal or face value of $10,000.

1B) What's the internal rate of return on the bond?

Continuing on from the last question:

2) If you can borrow money at 4% should you buy the bond? [Yes or No.]

3A) You are considering buying a car for $_____, and need to borrow the entire amount less a down payment of $3,000. You take out a loan that you will pay back in five annual installments of $_____. [Go on to 3B.]

3B) The first loan payment is due one year from the time you get the car, the second two years hence, etc. The salesman tells you that the loan payments include both principal and interest. [Go on to 3C.]

You will own the car after you make the last payment.

3C) What rate of interest are you paying on the loan?

4A) You are in the pizza business and want to buy a new pizza making machine. The machine costs $_____ today. At the end of each year you own the machine it will give you returns of $_____ after paying for maintenance and repairs. [Go on to 4B.]

After you have owned the machine for 6 years you expect to sell it for scrap for $1,000. (You scrap it at the same time you get the last $_____ return.)

4B) What is the internal rate of return on the machine?

Consider again the pizza machine in the last question. Would you buy the machine if you could borrow money at the following rates? [Answer Yes or No.]

5) 5%
6) 12%
7) 20%

8A) You win a big prize in the Super Lottery. You will receive $_____ today, and then $_____ for each of the succeeding 9 years. [Go on to 8B.]

8B) There are private parties who will buy your winning ticket for a lump sum payable today. In fact, one such person offers to pay you one half of your total winnings (10 times $_____). [Go on to 8C.]

Suppose you sell your ticket for the offered price.

8C) What rate of return is the buyer receiving on the investment?