Introduction

All of us who work in manufacturing industry well aware that labour and material cost going to increase from year to year due to yearly inflation cycle. In this situation you may accept it and to maintain at least same level of profitability increase you final products prices to the customer or try to find a way to decrease time required for labour related tasks (such as estimating, fabricating and etc.) and reduce material wastage during fabrication process. And in despite of our antagonism to computer and attachments to manual calculation it is only one solution to it. It is use of computerised estimating and material optimisation software. It will even save more time and money if you are able to obtain both capabilities in one software package.

"ACE Cutting" optimiser

"ACE Cutting" optimiser (www.acecut.com) had been developed by Adelaide Computer Energy, South Australian software company. By now it has quite a wide range of clients from structural steel to furniture manufactures. In this article I would like to give practical demonstration of benefits of using "ACE Cutting" optimiser in a furniture manufacturing industry.

Example

The sample project has been provided by owner of "Just A Dream Furniture" company. Peter never before had experience in using specialised software and he was very sceptical of possible benefits "ACE Cutting" optimiser may to offer. Nevertheless he always wants to free most of his Saturday time which he usually used to prepare next week takeoffs manually. Therefore he was agreed to give us a chance to prove him wrong and show all benefit of using "ACE Cutting" optimiser instead. Peter chooses a project which currently he has to accomplish for one of his customers. It was a dresser with 6 doors and 2 side headlights (see the final product picture in the Figure 1). He also entered all material required for this product into a MS Excel spreadsheet.

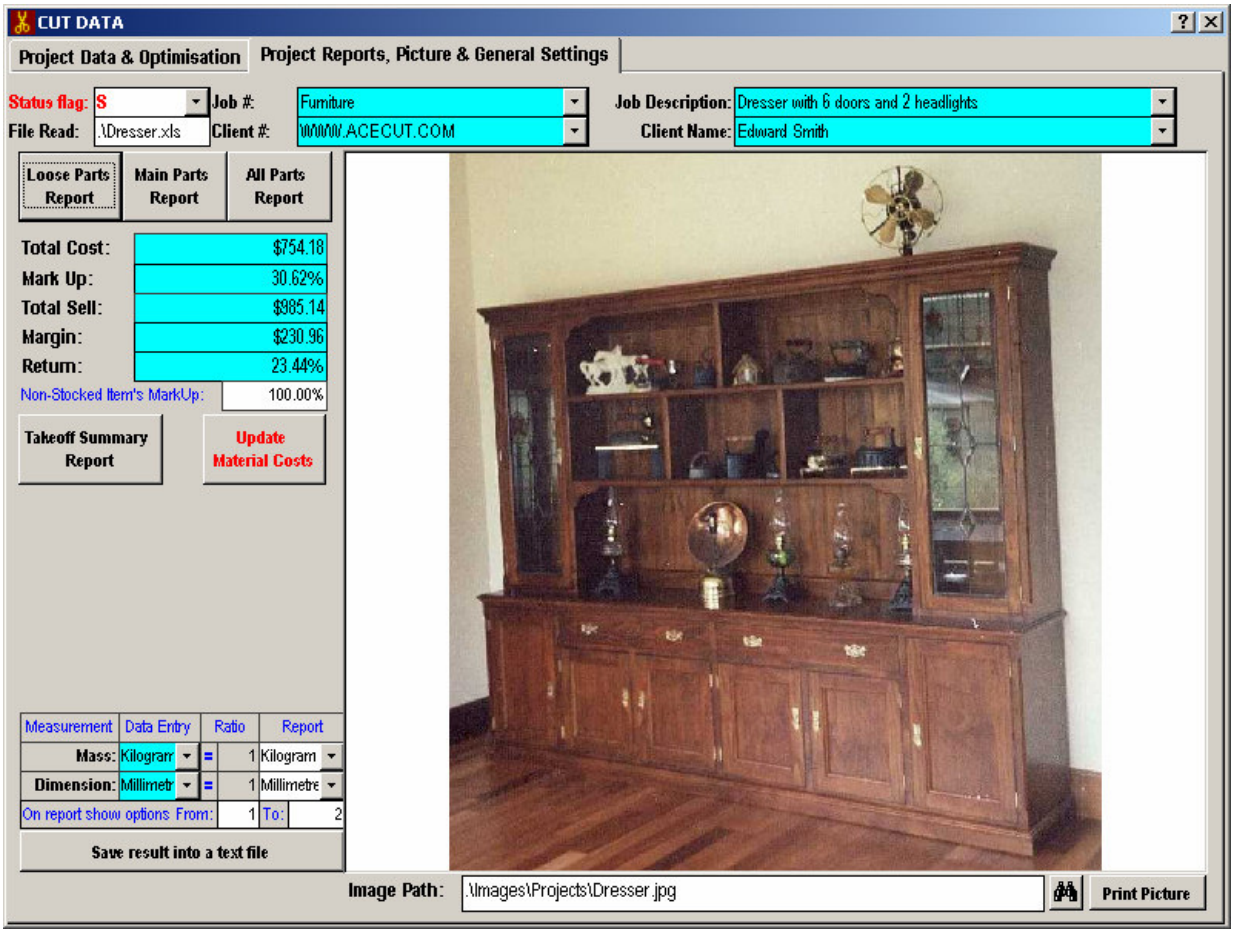


Figure 1

Initial Setup

To accomplish the task three steps has to been undertaken as following:

Step 1

Every different type of material in "ACE Cutting" optimiser conveniently grouped into material classes. And as it follows from the Peter's Excel spreadsheet takeoff dresser contains four unique material types which we decided to abbreviate as following:

1. VBP - Pine Veneer Board
2. PW - Plywood sheets
3. SPP - Solid pine planks
4. MB - Match boards

In accordance with above abbreviation we used "Item Classes Maintenance" form to enter data in the database (see Figure 2 for sample screen shot of VBP class).

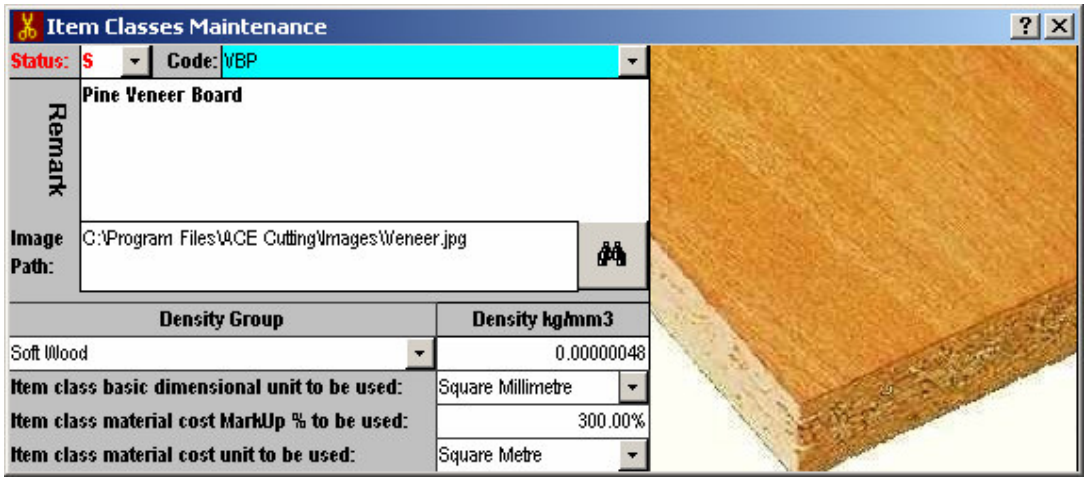


Figure 2

On the same form Peter has nominated square millimetre as a basic dimensional unit for VBP piece sizes. He also set square metre as VBP cost unit and 300%[1] as its default material cost mark-up. Similar entry has been done for PW and SPP materials. However MB has been set as leaner class of material as it only allowed to be cut by the length.

[1] By request of owner of "Just A Dream Furniture" costs and mark-ups in the text of this article does not correspond to real data company use in day to day operations. Values are shown just for demonstration purpures only.

Step 2

In turn each class of material may be obtained from Peter's suppliers in various thicknesses. He used "Item Classes Maintenance" form to enter item codes based on combination of item class abbreviation plus available material thickness.

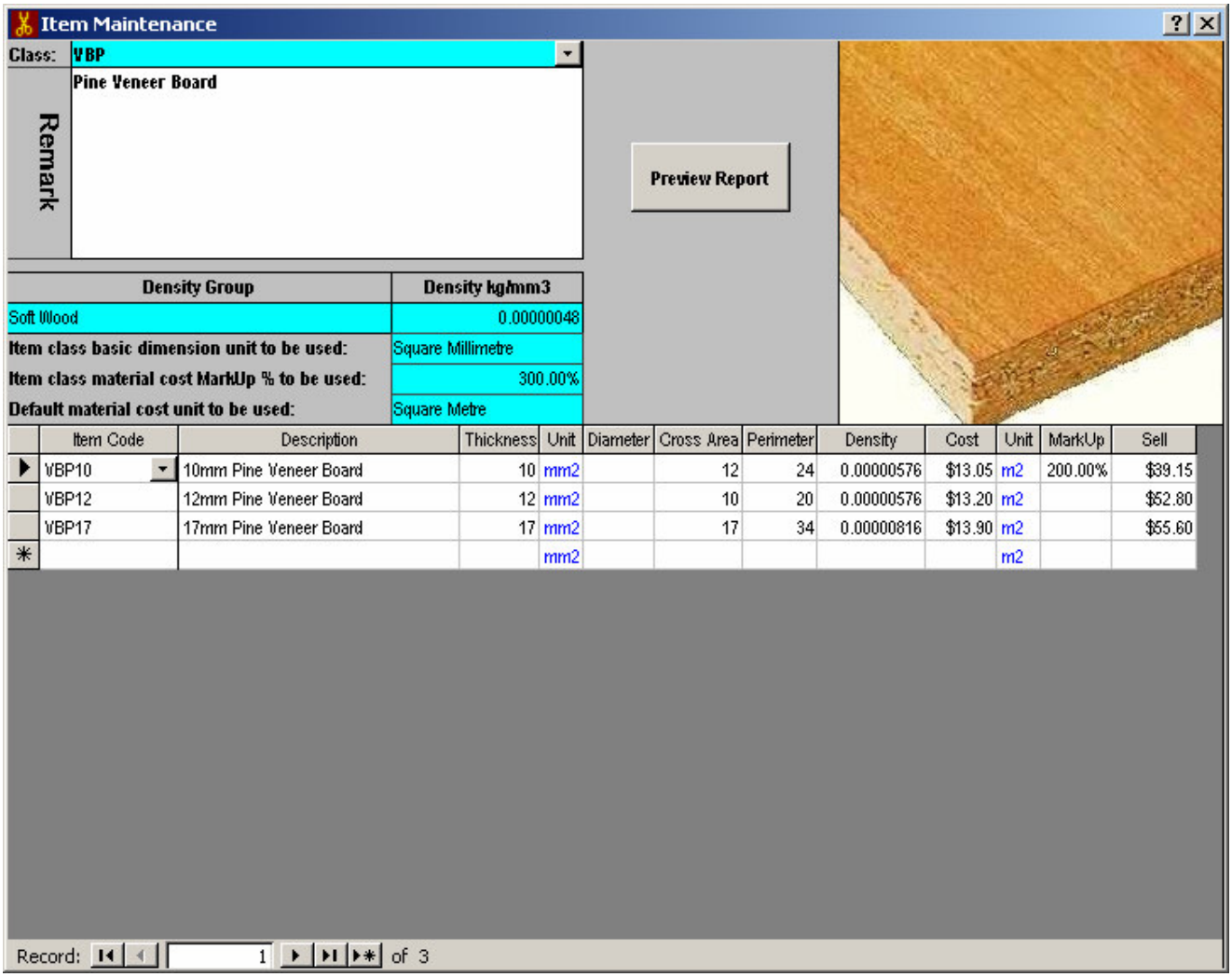


Figure 3

As you can see from the Figure 3 the pine veneer board may be obtained in 10mm, 12mm and 17mm thick with correspondent codes are VBP10, VBP12 and VBP17. Even if 10mm board was not used in the dresser's project he decided to enter it at this stage. This size board is most commonly used in his work. Plus he set it item cost mark-up to 200% to reduce final sell value to $39.15/m2 instead of $52.20/m2 based on default item class mark-up of 300%.

Step 3

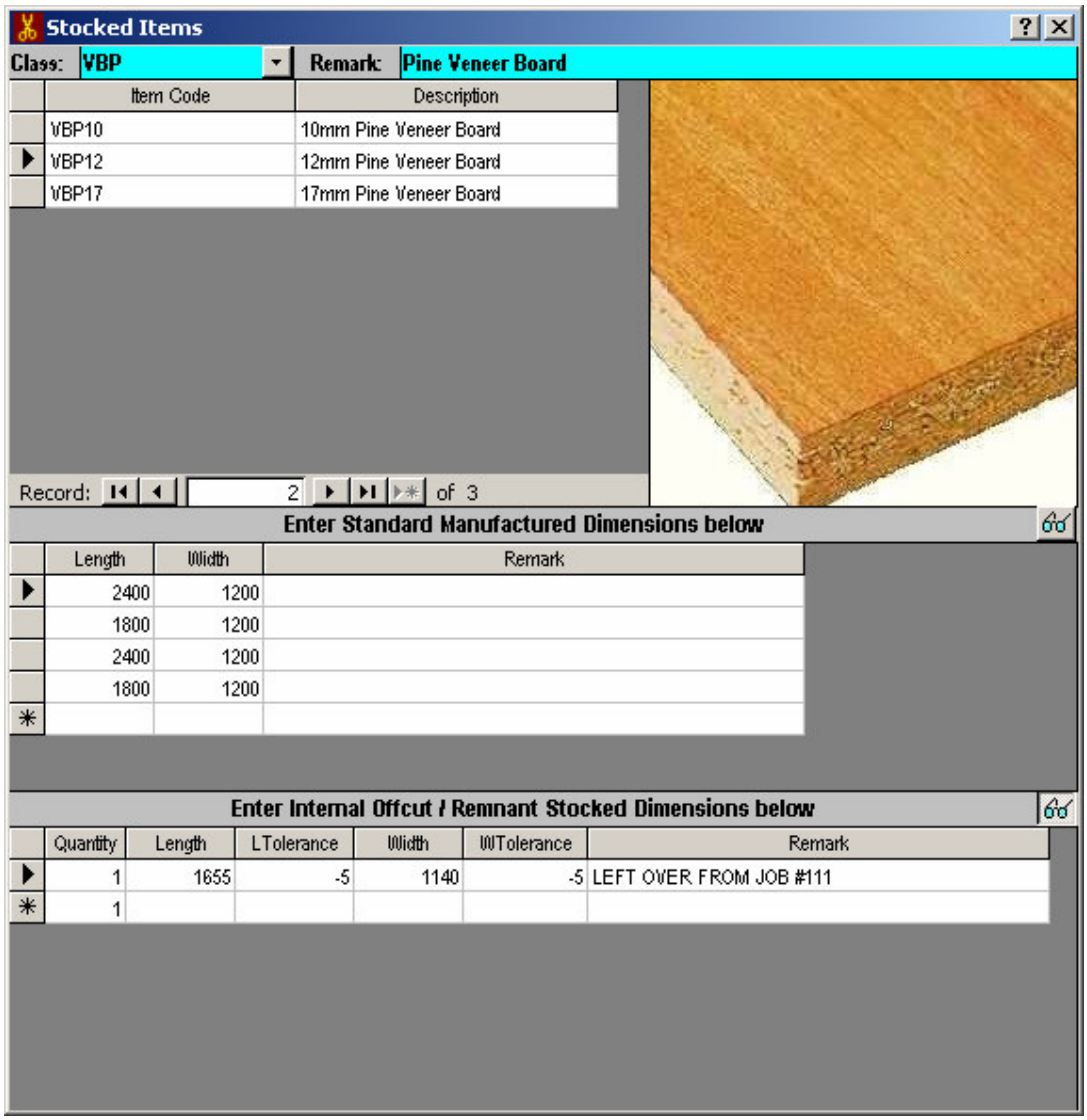


Figure 4

As the last step of the general setup he used “Stocked Items” form (see Figure 4) to enter material sizes which come from his suppliers (in program assumed it has unlimited quantity to cut from) and on the bottom part of the form he entered quantity and sizes of off cuts left over from his previous jobs. As you can see for remnant stock of VBP12 item he entered negative length and width tolerance to allow under cut in case of uneven ages.

I would like to stress here that three steps above has to be done ones only during initial setup of the new type of material. After that it is going to be used again and again in all following jobs.

Data exchange

As I indicate in the start of this article all data had been initially entered by Peter in MS Excel spreadsheet file. In “ACE Cutting” optimiser we can simply cut and paste data straight from Excel spreadsheet in to the project data sheet. But we are not going to do it here as we want to demonstrate program import capabilities.

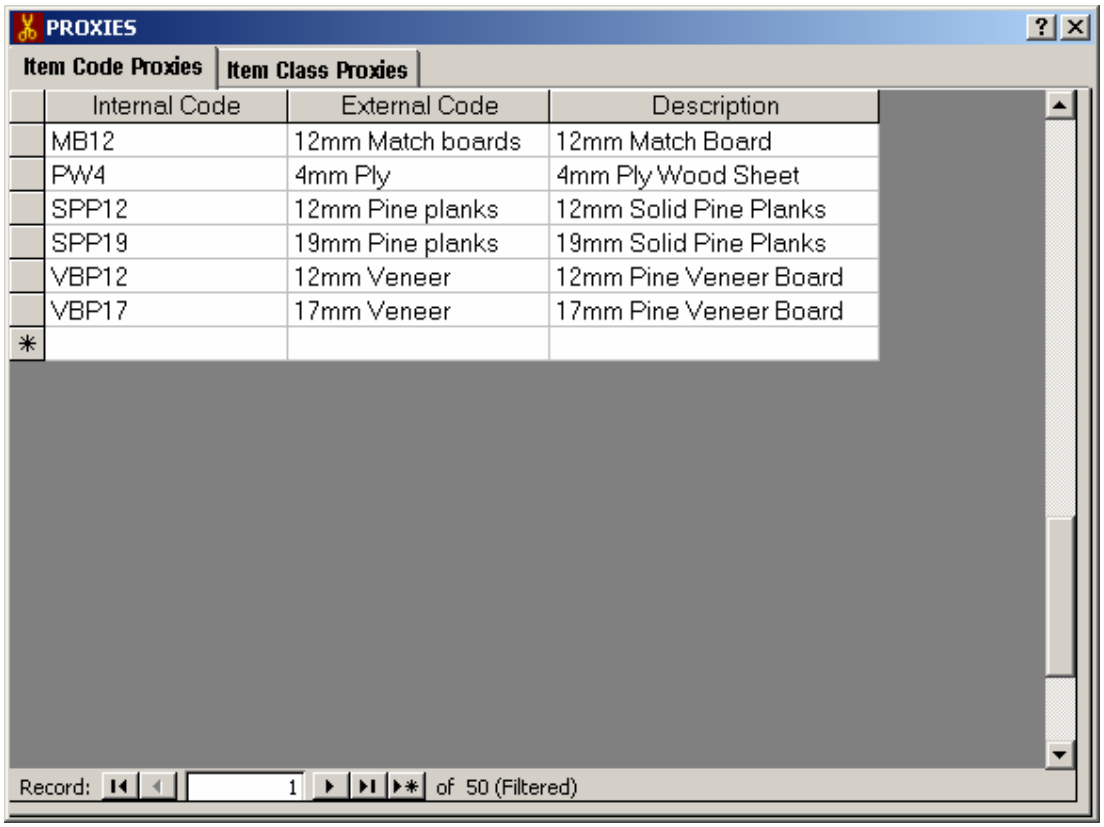


Figure 5

We used “Item Proxy” form (see Figure 5) to establish cross reference between Peter’s item descriptions from Excel spreadsheet and item codes established in the program (see Initial Setup section above).

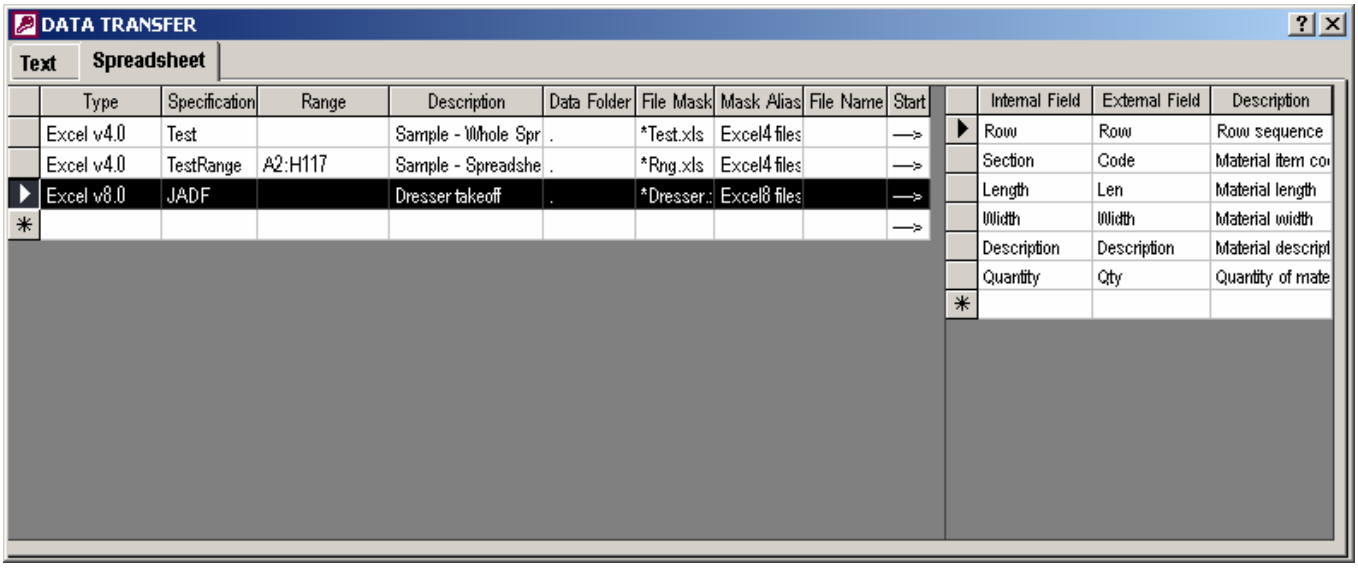
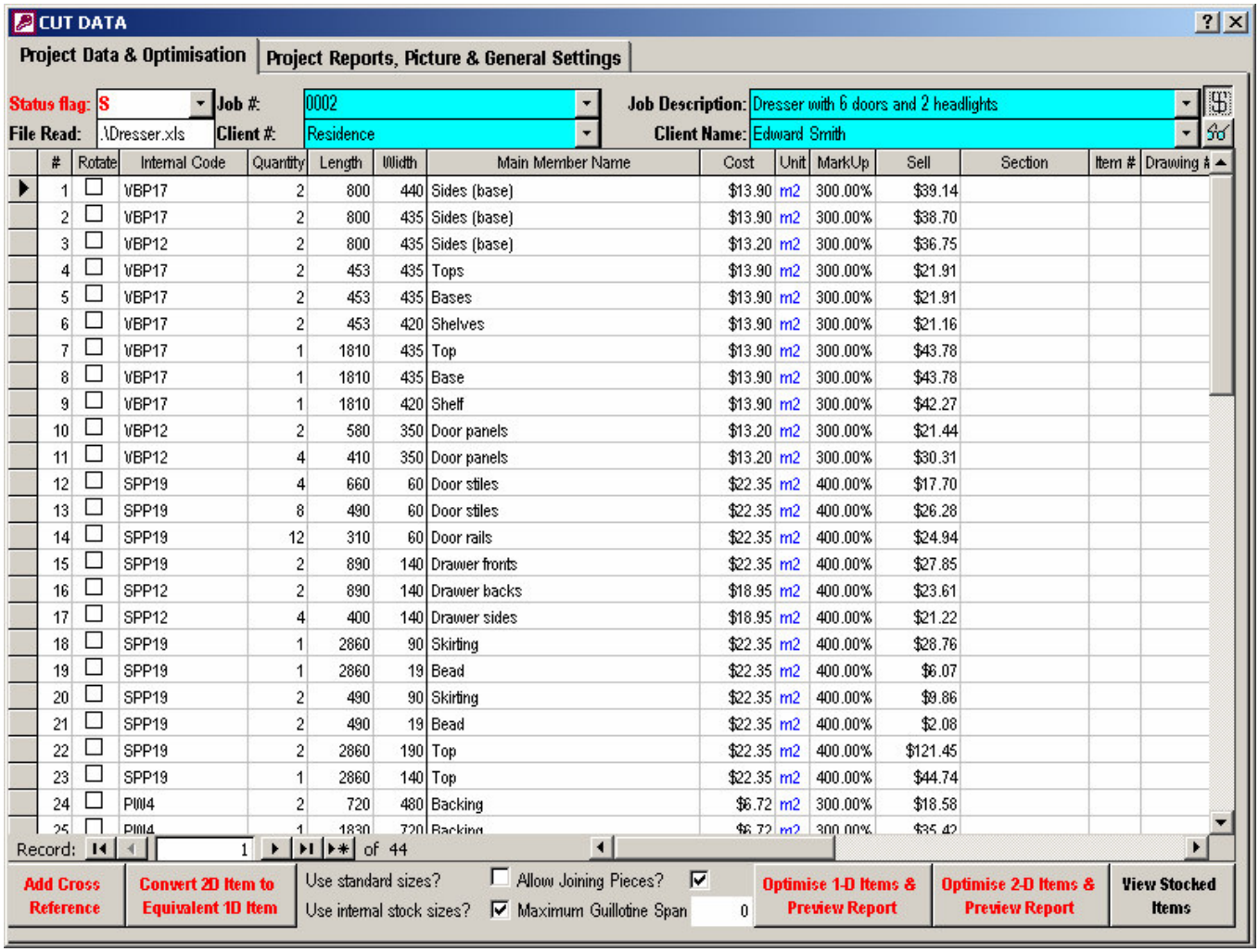


Figure 6

In “Transfer Data” form (see Figure 6) we selected Excel v8.0 as file format to be read and cross reference between program internal field names and column names in the Excel spreadsheet file (see right side of the

form Figure 6). Then we imported spreadsheet data in to the program by pressing arrow under “Start” column. This technique is useful if client(s) may provide material list in an Excel, Lotus Notes or even as a Text files. Data will be read with conversion from customer’s item description to appropriate item codes with costs and mark-ups values kept in the program.

Optimisation



#	Rotate	Internal Code	Quantity	Length	Width	Main Member Name	Cost	Unit	MarkUp	Sell	Section	Item #	Drawing #
1	☐	VBP17	2	800	440	Sides (base)	$13.90	m2	300.00%	$39.14			
2	☐	VBP17	2	800	435	Sides (base)	$13.90	m2	300.00%	$38.70			
3	☐	VBP12	2	800	435	Sides (base)	$13.20	m2	300.00%	$36.75			
4	☐	VBP17	2	453	435	Tops	$13.90	m2	300.00%	$21.91			
5	☐	VBP17	2	453	435	Bases	$13.90	m2	300.00%	$21.91			
6	☐	VBP17	2	453	420	Shelves	$13.90	m2	300.00%	$21.16			
7	☐	VBP17	1	1810	435	Top	$13.90	m2	300.00%	$43.78			
8	☐	VBP17	1	1810	435	Base	$13.90	m2	300.00%	$43.78			
9	☐	VBP17	1	1810	420	Shelf	$13.90	m2	300.00%	$42.27			
10	☐	VBP12	2	580	350	Door panels	$13.20	m2	300.00%	$21.44			
11	☐	VBP12	4	410	350	Door panels	$13.20	m2	300.00%	$30.31			
12	☐	SPP19	4	660	60	Door stiles	$22.35	m2	400.00%	$17.70			
13	☐	SPP19	8	490	60	Door stiles	$22.35	m2	400.00%	$26.28			
14	☐	SPP19	12	310	60	Door rails	$22.35	m2	400.00%	$24.94			
15	☐	SPP19	2	890	140	Drawer fronts	$22.35	m2	400.00%	$27.85			
16	☐	SPP12	2	890	140	Drawer backs	$18.95	m2	400.00%	$23.61			
17	☐	SPP12	4	400	140	Drawer sides	$18.95	m2	400.00%	$21.22			
18	☐	SPP19	1	2860	90	Skirting	$22.35	m2	400.00%	$28.76			
19	☐	SPP19	1	2860	19	Bead	$22.35	m2	400.00%	$6.07			
20	☐	SPP19	2	490	90	Skirting	$22.35	m2	400.00%	$9.86			
21	☐	SPP19	2	490	19	Bead	$22.35	m2	400.00%	$2.08			
22	☐	SPP19	2	2860	190	Top	$22.35	m2	400.00%	$121.45			
23	☐	SPP19	1	2860	140	Top	$22.35	m2	400.00%	$44.74			
24	☐	PW4	2	720	480	Backing	$6.72	m2	300.00%	$18.58			
25	☐	PW4	1	1830	720	Backing	$6.72	m2	300.00%	$35.42			

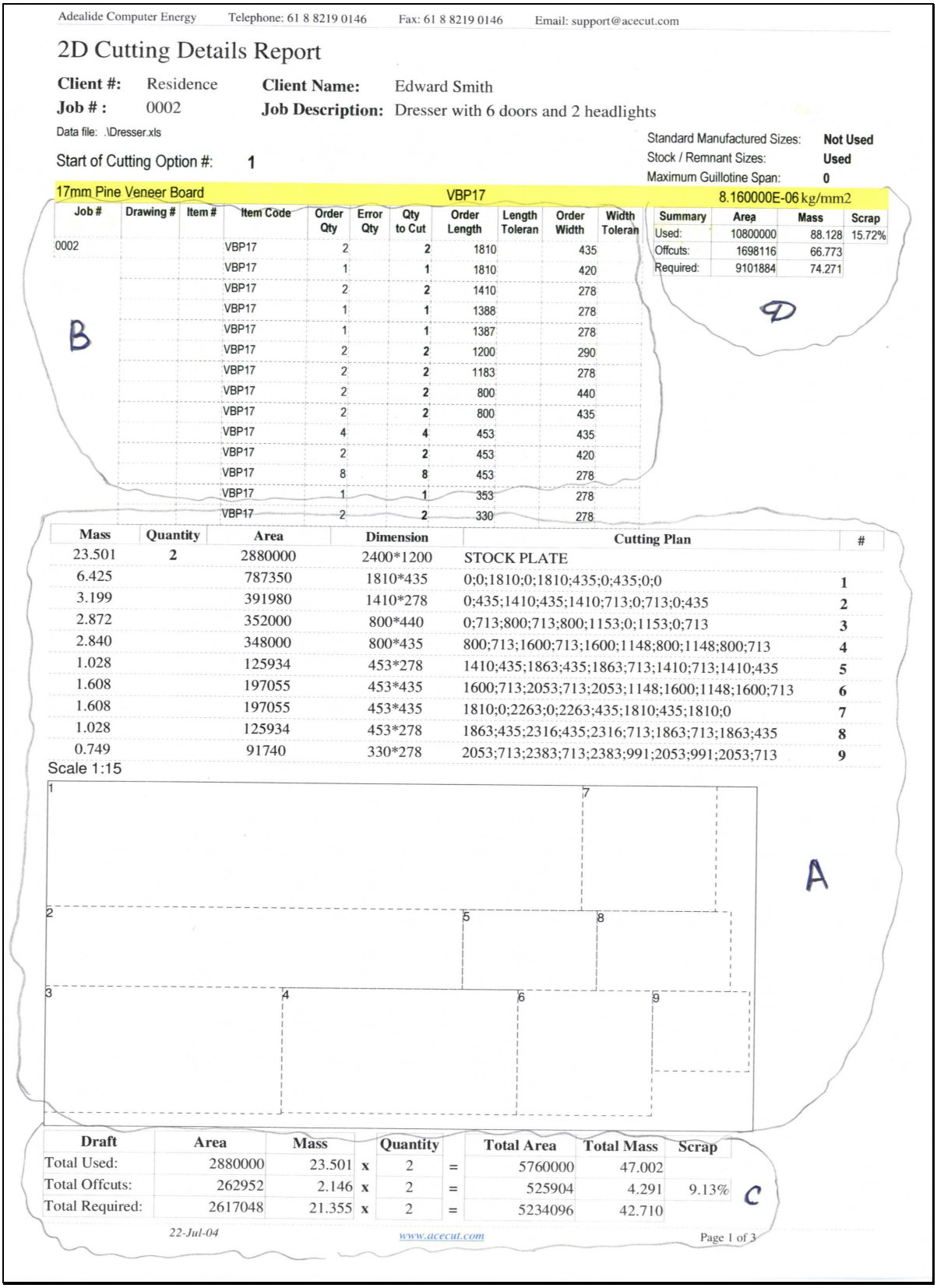
Record: 1 of 44

Figure 7

New and existing project can be accessed through “Cut Data” form (see Figure 7).
At this point Peter just recall dresser projects, pressed “Optimise 1D…” and “Optimise 2D…” buttons and got optimised layouts for one and two dimensional items in seconds (see result in Figure 8 and Figure 9 correspondently).
The second tab of the form (see Figure 1) has buttons to preview and print different reports, costing summary, numerous setting and picture of the selected project.
Peter always likes to take a picture of his finished product (see Figure 1). He keeps these pictures on his computer hard drive as his products catalogue. As of his experience most of the customers just like to browse through the catalogue and order product which comes closest to they requirement with adding/extracting an extra feature to/from it. So he straight realised that by linking product picture from the catalogue to the project inside “ACE Cutting” optimiser he will be able to reuse existing data without necessity to type material takeoff again and again.

Reports

Reporting part of a program is and should be a most valuable part of any software application. “ACE Cutting” optimiser is no exception with seven different report ready for Peter perusal. Here I would like to shortly describe three most important of them all.



Adealide Computer Energy Telephone: 61 8 8219 0146 Fax: 61 8 8219 0146 Email: support@acecut.com

2D Cutting Details Report

Client #: Residence **Client Name:** Edward Smith

Job # : 0002 **Job Description:** Dresser with 6 doors and 2 headlights

Data file: .\Dresser.xls

Start of Cutting Option #: 1

Standard Manufactured Sizes: **Not Used**
Stock / Remnant Sizes: **Used**
Maximum Guillotine Span: **0**

17mm Pine Veneer Board VBP17 8.160000E-06 kg/mm2

Job #	Drawing #	Item #	Item Code	Order Qty	Error Qty	Qty to Cut	Order Length	Length Toleran	Order Width	Width Toleran
0002			VBP17	2		2	1810		435	
			VBP17	1		1	1810		420	
			VBP17	2		2	1410		278	
			VBP17	1		1	1388		278	
			VBP17	1		1	1387		278	
			VBP17	2		2	1200		290	
			VBP17	2		2	1183		278	
			VBP17	2		2	800		440	
			VBP17	2		2	800		435	
			VBP17	4		4	453		435	
			VBP17	2		2	453		420	
			VBP17	8		8	453		278	
			VBP17	1		1	353		278	
			VBP17	2		2	330		278	

Summary	Area	Mass	Scrap
Used:	10800000	88.128	15.72%
Offcuts:	1698116	66.773	
Required:	9101884	74.271	

B

D

Mass	Quantity	Area	Dimension	Cutting Plan	#
23.501	2	2880000	2400*1200	STOCK PLATE	
6.425		787350	1810*435	0;0;1810;0;1810;435;0;435;0;0	1
3.199		391980	1410*278	0;435;1410;435;1410;713;0;713;0;435	2
2.872		352000	800*440	0;713;800;713;800;1153;0;1153;0;713	3
2.840		348000	800*435	800;713;1600;713;1600;1148;800;1148;800;713	4
1.028		125934	453*278	1410;435;1863;435;1863;713;1410;713;1410;435	5
1.608		197055	453*435	1600;713;2053;713;2053;1148;1600;1148;1600;713	6
1.608		197055	453*435	1810;0;2263;0;2263;435;1810;435;1810;0	7
1.028		125934	453*278	1863;435;2316;435;2316;713;1863;713;1863;435	8
0.749		91740	330*278	2053;713;2383;713;2383;991;2053;991;2053;713	9

Scale 1:15

A

Draft	Area	Mass		Quantity		Total Area	Total Mass	Scrap
Total Used:	2880000	23.501	x	2	=	5760000	47.002	
Total Offcuts:	262952	2.146	x	2	=	525904	4.291	9.13%
Total Required:	2617048	21.355	x	2	=	5234096	42.710	

C

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Figure 8

First one is “2D Cutting Details” report (see Figure 8). It has four main areas to look at:

A) Grouped by item code optimised layout together with the quantity, dimension, mass, coordinate and sequence number of each piece shown in layout on the page.
B) Quantity of material collated by sizes.
C) Summary of pieces used for this layout.
D) And at the start of each group of material a summary of all layouts on report.

The “Start of Cutting Option #: 1” represents that report will show number of options if same set of pieces may be laid onto stock piece in several different ways with the same percentage of wastage. Hence user may choose an option which will be more economical in time required for actual cutting process.

See “1D Cutting & Joining Details” report at the end of this document

Figure 9

Second is “1D Cutting & Joining Details” report (see Figure 9). This report has several sections similar to described in first report above and others are self-explanatory. Only one which I would like to mention is “Joining plan” section. In here (if user allow doing so) program show how to optimally join different pieces together. Then result piece is used in optimisation of material which is longer then maximum stock item length (see Figure 9 under “Cutting Plan” section of report).

See “Project Takeoff Summary” report at the end of this document

Figure 10

The third “Project Takeoff Summary” report (see Figure 10) Peter found especially useful. This report provides grouped by item class project costing information. As he said this report let him to prepare accurate client’s invoice in seconds.

Statistics

At this point as I promise in the first part of this article I will show actual benefit of using "ACE Cutting" optimiser in terms of saving in labour time and dollar values. The time savings poorly comes in comparison of time needed to do same project by hand to time taken to accomplish it with the help of "ACE Cutting" optimiser software. From another side dollar value savings are compound by savings in labour related tasks plus cost of savings in material wastage compare to wastage in manual calculation.
Peter does not own very powerful computer. We installed "ACE Cutting" software on his Pentium II, 350 MHz machine with 32MB of RAM. He provided us with the time in minutes which he spent for each of the five steps required to accomplish the dresser project. His data listed in Table 1 under "Manual" column. Then we timed out program to do same tasks. See result in Table 1under "Software" column. The dollar value variance was calculated on base of labour cost of $50.00 dollars per hour.

Table 1

Task	Manual	Software	Time Variance	$ Variance.
Prepare material list	30	30	0	$ 0.00
Data entry	15	5	10	$ 8.33
Cost Estimating	20	0.03	19.97	$ 16.64
1D Cutting Optimisation	15	0.05	14.95	$ 12.46
2D Cutting Optimisation	75	0.35	74.65	$ 62.21
TOTAL SAVINGS:	**155**	**35.43**	**119.57**	**$ 99.64**

Table 2 shows percentage of material wasted in manual and computer calculation correspondently. As you can see only half of materials in program optimisation have a variance in compare to manual calculation. Other half has zero variance which we may attribute to insufficient quantity of pieces in optimisation.

Table 2

Material in optimisation	Pieces	Manual	Software	% Variance	$ Cost	$ Variance
12mm Match Boards	28	4.45	1.22	3.23	47.77	$ 1.54
12mm Solid Pine Planks	6	6.11	6.11	0.0	8.81	$ 0.00
19mm Solid Pine Planks	44	16.06	8.66	7.4	77.32	$ 5.72
12mm Pine Veneer	8	22.41	22.41	0.0	23.29	$ 0.00
17mm Pine Veneer	31	23.54	15.72	7.82	126.52	$ 9.89
4mm Plywood Sheets	3	9.28	9.28	0.0	13.50	$ 0.00
TOTAL SAVINGS:	-	-	-	-	-	**$ 17.15**

Summary

This simple demonstration shows that just in one job it is quite possible to save over $115.00 dollars in labour cost and material. In addition if we assume pessimistically that Peter has only one takeoff to do a week he still going to save at least 2 hours per week for his family or hobby. Another factor to consider is that his entire projects going to be kept in searchable order inside of "ACE Cutting" optimiser. And he has to do nothing (in regards of data processing) if a customer chooses to order a product from his catalogue.

Adealide Computer Energy Telephone: 61 8 8219 0146 Fax: 61 8 8219 0146 Email: support@acecut.com

1D Cutting & Joining Details Report

Client #: Residence **Client Name:** Edward Smith

Job # : 0002 **Job Description:** Dresser with 6 doors and 2 headlights

Data file:

Standard Manufactured Lengths: **Not Used**
Internal / Remnant Lengths: **Used**
Joining Stock Pieces: **Allowed**

Start of Cutting Option #: **1**

12mm Match board MB12 5.76000E-06 kg/mm

Mass	Quantity	Base Length	Cutting Plan	Offcut	Total Offcut	Mass	Scrap
0.012	1	2025	2*1010	5	5	0.000029	0.25%
0.166	12	2400	2*1200	0	0	0	0.00%

Joining Plan	Joined Length
1*1020+1*1005	2025

Summary	Length	Mass	Scrap
Total Used:	30,825.00	0.178	
Total Offcuts:	5	0.000	0.02%
Total Required:	30820	0.178	

Project Takeoff Summary Report

Client #: Residence **Client Name:** Edward Smith
Job # : 0002 **Job Description:** Dresser with 6 doors and 2 headlights

Data file: .\Dresser.xls

Area (m2);	16.719244	**Total Cost:**	$756.24		**Profitability**
Surface (m2);	44.718622	**Average MarkUp:**	28.65%	**Total Margin:**	$130.92
Mass (kg);	122.636308898	**Total Sell:**	$1,871.27	**Total Return:**	22.27%

Item Class #: N/A **Description:** UNCLASSIFIED MATERIALS

Item Code	Description	Qty	Length	Width	Area (m2)	Surface (m2)	Mass (kg)	Cost	Unit	MarkUp	Sell
	Drawer knobs	4						$1.40	U	200.00%	$16.80
	Hinges	18						$0.42	U	200.00%	$22.68
	Labour	3						$35.00	U	20.00%	$126.00
	Leadlights	2						$75.00	U	20.00%	$180.00
	Polish	1						$180.00	U	20.00%	$216.00
	Door knobs	8						$1.10	U	200.00%	$26.40

Area (m2):		**Total Cost:**	$456.96		**Profitability**
Surface (m2):		**Average MarkUp:**	28.65%	**Total Margin:**	$130.92
Mass (kg):		**Total Sell:**	$587.88	**Total Return:**	22.27%

Item Class #: MB **Description:** Match board

Item Code	Description	Qty	Length	Width	Area (m2)	Surface (m2)	Mass (kg)	Cost	Unit	MarkUp	Sell
MB12	Door insert headlight panels	2	1.01			0.53328	0.01163520	$1.65	m	300.00%	$13.33
MB12	Backing	24	1.2			7.6032	0.16588800	$1.65	m	300.00%	$190.08

Area (m2):		**Total Cost:**	$50.85		**Profitability**
Surface (m2):	8.13648	**Average MarkUp:**	300.00%	**Total Margin:**	$152.56
Mass (kg):	0.17752320067	**Total Sell:**	$203.41	**Total Return:**	75.00%

Item Class #: PW **Description:** Plywood sheets

Item Code	Description	Qty	Length	Width	Area (m2)	Surface (m2)	Mass (kg)	Cost	Unit	MarkUp	Sell
PW4	Backing	1	1.83	0.72	1.3176	2.6556	2.79331212	$6.72	m2	300.00%	$35.42
PW4	Backing	2	0.72	0.48	0.6912	1.4016	1.46534406	$6.72	m2	300.00%	$18.58

Area (m2):	2.0088	**Total Cost:**	$13.50		**Profitability**
Surface (m2):	4.0572	**Average MarkUp:**	300.00%	**Total Margin:**	$40.50
Mass (kg):	4.25865618108	**Total Sell:**	$54.00	**Total Return:**	75.00%

Item Class #: SPP **Description:** Solid Pine Planks

Item Code	Description	Qty	Length	Width	Area (m2)	Surface (m2)	Mass (kg)	Cost	Unit	MarkUp	Sell
SPP12	Drawer sides	4	0.4	0.14	0.224	0.49984	1.29024000	$18.95	m2	400.00%	$21.22
SPP12	Drawer backs	2	0.89	0.14	0.2492	0.54784	1.43539201	$18.95	m2	400.00%	$23.61
SPP19	Top	2	2.86	0.19	1.0868	2.4054	9.91161596	$22.35	m2	400.00%	$121.45
SPP19	Door rails	16	0.31	0.06	0.2976	0.82016	2.71411199	$22.35	m2	400.00%	$33.26
SPP19	Bead	2	0.49	0.019	0.01862	0.075924	0.1698144	$22.35	m2	400.00%	$2.08
SPP19	Door stiles	8	0.49	0.06	0.2352	0.6376	2.14502399	$22.35	m2	400.00%	$26.28
SPP19	Skirting	2	0.49	0.09	0.0882	0.22048	0.804384	$22.35	m2	400.00%	$9.86
SPP19	Door stiles	4	0.66	0.06	0.1584	0.42624	1.44460799	$22.35	m2	400.00%	$17.70
SPP19	Drawer fronts	2	0.89	0.14	0.2492	0.57668	2.27270399	$22.35	m2	400.00%	$27.85
SPP19	Door stiles	4	1.13	0.06	0.2712	0.72328	2.47334399	$22.35	m2	400.00%	$30.31
SPP19	Bead	1	2.86	0.019	0.05434	0.218082	0.4955808	$22.35	m2	400.00%	$6.07
SPP19	Top mouldings	1	3.8	0.09	0.342	0.83182	3.11903999	$22.35	m2	400.00%	$38.22
SPP19	Top	1	2.86	0.14	0.4004	0.9148	3.65164798	$22.35	m2	400.00%	$44.74
SPP19	Skirting	1	2.86	0.09	0.2574	0.6269	2.34748799	$22.35	m2	400.00%	$28.76

Area (m2):	3.93256	**Total Cost:**	$86.28		**Profitability**
Surface (m2):	9.525046	**Average MarkUp:**	400.00%	**Total Margin:**	$345.14
Mass (kg):	34.2749950678	**Total Sell:**	$431.42	**Total Return:**	80.00%

Item Class #: VBP **Description:** Pine Veneer Board

Item Code	Description	Qty	Length	Width	Area (m2)	Surface (m2)	Mass (kg)	Cost	Unit	MarkUp	Sell
VBP12	Door panels	4	0.41	0.35	0.574	1.22096	3.30624001	$13.20	m2	300.00%	$30.31
VBP12	Door panels	2	0.58	0.35	0.406	0.85664	2.33856001	$13.20	m2	300.00%	$21.44
VBP12	Sides (base)	2	0.8	0.435	0.696	1.45128	4.00896002	$13.20	m2	300.00%	$36.75
VBP17	Bases	2	0.453	0.435	0.39411	0.848604	3.21593764	$13.90	m2	300.00%	$21.91
VBP17	Base	1	1.81	0.435	0.78735	1.65103	6.42477608	$13.90	m2	300.00%	$43.78
VBP17	Shelf	1	1.81	0.42	0.7602	1.59622	6.20323208	$13.90	m2	300.00%	$42.27
VBP17	Shelves	2	1.41	0.278	0.78396	1.682704	6.39711368	$13.90	m2	300.00%	$43.59
VBP17	Top	1	1.388	0.278	0.385864	0.828372	3.14865028	$13.90	m2	300.00%	$21.45
VBP17	Top	1	1.387	0.278	0.385586	0.827782	3.14638180	$13.90	m2	300.00%	$21.44
VBP17	Sides	2	1.2	0.29	0.696	1.49332	5.67936007	$13.90	m2	300.00%	$38.70
VBP17	Sides	2	1.183	0.278	0.657748	1.414844	5.36722375	$13.90	m2	300.00%	$36.57
VBP17	Sides (base)	2	0.8	0.44	0.704	1.49232	5.74464008	$13.90	m2	300.00%	$39.14
VBP17	Tops	2	0.453	0.435	0.39411	0.848604	3.21593764	$13.90	m2	300.00%	$21.91
VBP17	Shelves	2	0.453	0.42	0.38052	0.820404	3.10504324	$13.90	m2	300.00%	$21.16
VBP17	Shelves	8	0.453	0.278	1.007472	2.213776	8.22097163	$13.90	m2	300.00%	$56.02
VBP17	Division	1	0.353	0.278	0.098134	0.217722	0.80077345	$13.90	m2	300.00%	$5.46
VBP17	Division	2	0.33	0.278	0.18348	0.408304	1.49719682	$13.90	m2	300.00%	$10.20
VBP17	Top	1	1.81	0.435	0.78735	1.65103	6.42477608	$13.90	m2	300.00%	$43.78
VBP17	Sides (base)	2	0.8	0.435	0.696	1.47598	5.67936007	$13.90	m2	300.00%	$38.70

Area (m2):	10.777884	**Total Cost:**	$148.64		**Profitability**
Surface (m2):	22.999896	**Average MarkUp:**	300.00%	**Total Margin:**	$445.92
Mass (kg):	83.9251344480	**Total Sell:**	$594.56	**Total Return:**	75.00%