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Basic “LL-41 - Arunda” solution

(for manufacturing of log shells and log works)

Description

- Proposed solution is intended for small businesses manufacturing milled log home kits or companies developing properties.
- Such solution will allow manufacturing of 5-12 log shells per year for average area homes (~2000 sq ft).
- All prices shown in this document do not include delivery and taxes and can be changed without notification.

Specification

	Equipment	Price, USD	Purpose
1	Log Lathe LL-41	\$24,900.00	Log turning, Milling of Round Notch, Milling of lengthwise Swedish Cope, Kerfing
2	Arunda 6”x10” manual tenoner AR120 & Mafell LO 65 Ec Hand Router with 1/2” collet - 230 volt Maxi in Max Box	\$3,500.00	- Butt to butt log connection - Rafters & Joists connections - beams connection - Butt-n-Pass log connection - timber framing

Other required equipment & tools

	Equipment	Purpose
1	All-terrain forklift or tractor with forks	- Log delivery to log lathe - Removing of log from the lathe
2	Chain saw	Log cross cut
3	Diesel electric power generator (not required if 3 phase hydro power is available)	25KW generator can be ordered locally (some our clients buy used generators) Woodlandia can supply one: 23 kw 28.75 kva Yanmar powered 480V generator with Stamford Alternator CA\$10,640.00
4	Portable power generator for Mafell router	1 phase 220V, 50Hz
5	Compact utility tractor or Bobcat with loader	Remove waste (wood chips)
6	Air compressor	Small (garage size) unit to clean up LL-41
7	Peavy, cant hook, log dogs, hookeroon	For manual log handling
8	Crane	For log lifting when assembling log works

Options

	Equipment	Price, USD	Purpose
1	Set of 4 dovetail jigs for chain saw	\$2,000.00	Dovetail style log home corners for round and squarish profiles 6"x6", 6"x8", 8"x8", 8"x10"
2	Stationary log cross cutting machine, LT-1	from \$4,900.00	LT-1 requires surrounding roll-tables (26 ft from one side + 26 ft from other)
3	Heavy duty roll tables	\$250.00 / ln m (about \$78/ln ft)	
4	Dedicated notch maker kit NM-1K	\$7,900.00	Notching station. It allows milling of round notches in different angles (by default: 90 and 45). This is machines kit, it requires some customization works on owner's side.
5	Stationary log mortising machine (tenoner), LJ-1	\$4,900.00	Mill tenons in log's butt for openings and log butt-to-butt connections

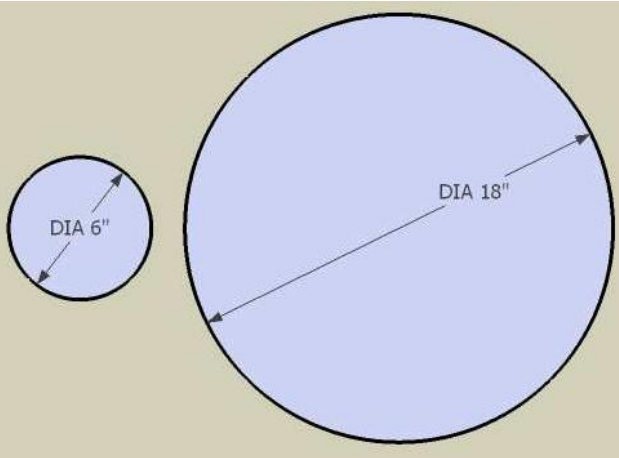



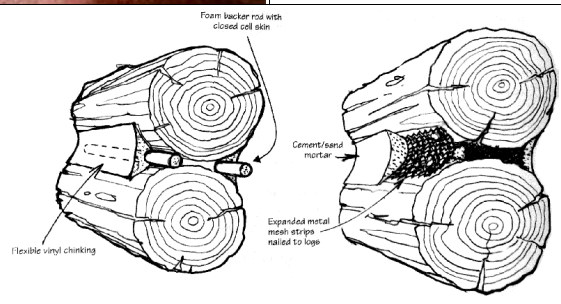
Log Works

House logs will be milled on LL-41. Log will be delivered and removed to/from the lathe by the forklift.

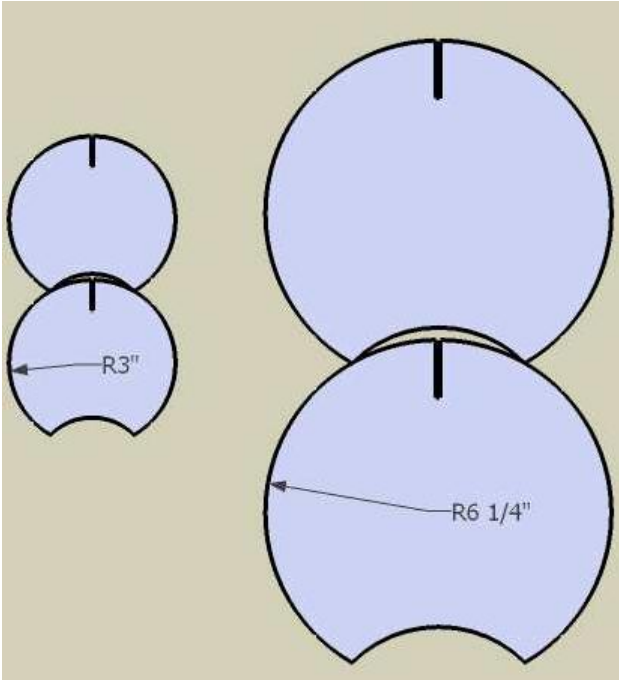
Round notches will be milled on LL-41.

Dovetails can be cut using chain saw and dovetail jigs

Log profiles

	Pictures	Notes
1	 <p>Manufacturing time: 5-20 minutes (depending on log shape, taper, structure)</p> <p>Time does not include delivery of the log to log lathe, setup of log on the lathe and removing of the log from the lathe after processing</p>	<p>Min diameter: 6" (150mm) Max diameter: up to 18" (460mm) , depending on taper of used raw log Notching: same as for next profile Usage:</p> <ul style="list-style-type: none"> - log walls - But-n-pass style log homes as shown on the right picture - Post-and-beams homes (right bottom corner picture) - Poles, posts, purlins, ridges <p>Insulation methods: Chinking as shown on pictures below.</p>    

2



Manufacturing time: as for round profile + up to 5 minutes to mill Swedish Cope and saw Kerfing + up to 5 minutes for each notch



Min diameter: 6" (150mm)

Max diameter: 12.5 (320mm). Theoretically this profile can be used with logs up to 18" in diameter however LL-41 does not mill round notches for diameters more than 12.5" (320mm)

Notching:

For notches bigger than 12.5" in diameter, Woodlandia' NM-3 log notching machine can be used. NM-3 can mill round notches for logs with diameters in range 6 and 16" (160-410mm).

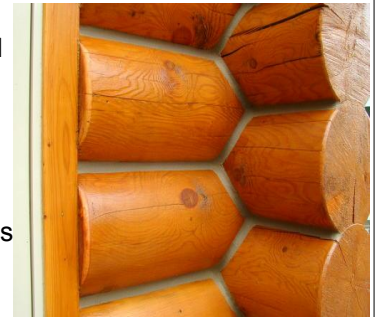
Also handcrafted notching methods can be used with this log profile.

Usage:

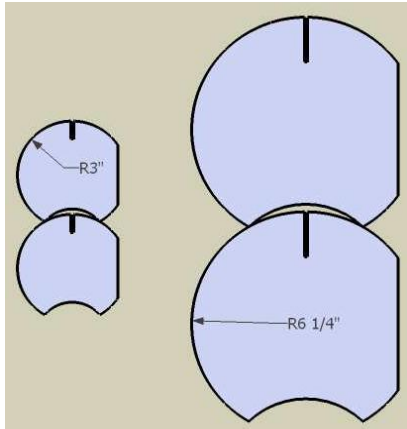
log walls

Insulation methods:

- chinking
- PVC single or double sided foam tape
- Foam
- certain type natural moss



3

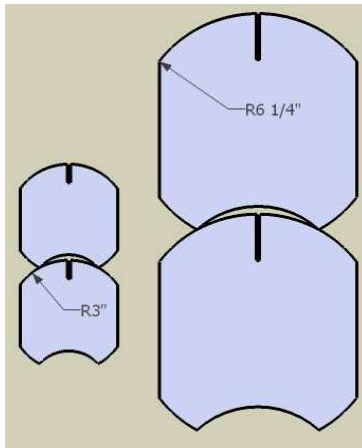


Manufacturing time: as for previous profile + up to 10 minutes to flatten one side of the log by vertical cutter head knives of LL-41 (time depends on how thick layer of wood is to be removed)

Min & max log diameters: same as for previous profile.
Insulation methods: same as for for previous profile.
Notching: same as for for previous profile.
Usage: log walls



4



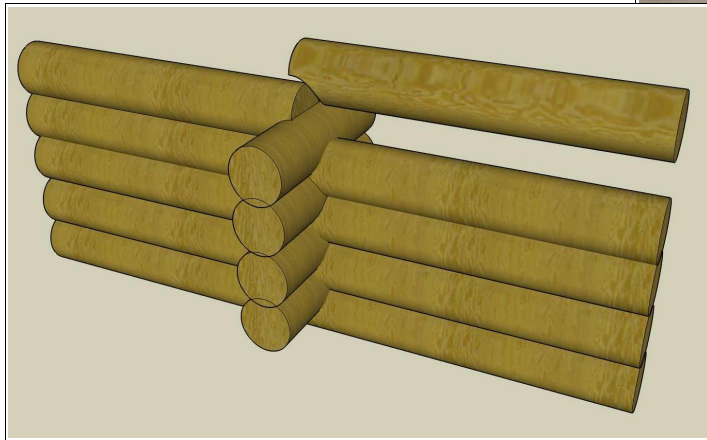
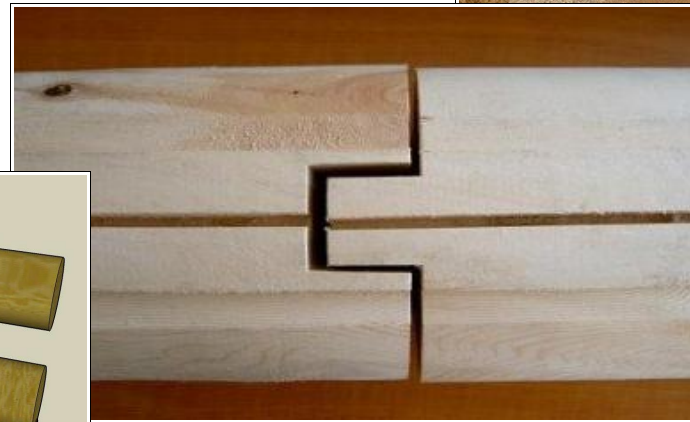
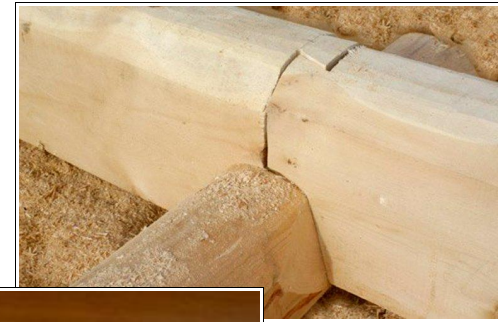
Manufacturing time: as for previous profile + up to 10 minutes to flatten other side of the log by vertical cutter head knives of LL-41 (time depends on how thick layer of wood is to be removed)

Min & max log diameters: same as for previous profile.
Insulation methods: same as for for previous profile.
Notching: same as for for previous profile.
Usage: house logs (walls)

Butt-to-Butt Log Interconnection



To extend log wall length following methods can be used:

1. dovetail connection (made with Arunda tenoner)
2. log interconnection hidden in corner as shown on picture below
3. combined methods 1 and 2 (dovetail connection hidden in corner)
4. Handcrafted techniques



Roof systems

Following roof system can be used (manufactured):

	Type of roof system	Pictures	Note
1	prefabricated trusses		- Ordered from 3d party
2	"in-house" made trusses		Trusses can be manufactured "in-house" from local lumber or lumber milled "in-house"

3 handcrafted log trusses



Hand-peeled or manufactured (on LL-41) logs can be used for log trusses

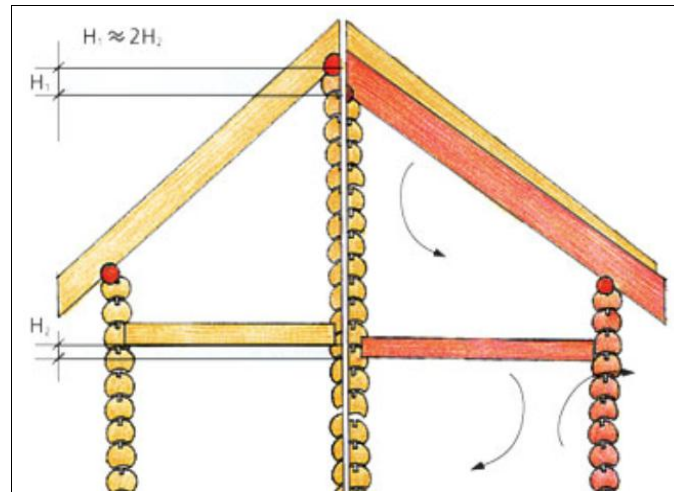
4 poles(posts) & purlins



Tenons for log connection will be made manually

Hand-peeled or manufactured on LL-41 logs can be used for post and purlins.

5 Scandinavian style
roof system










No need for trusses.

However this method has downside:
Rafters should be specially fixed to
walls. When log work will shrink,
roof pitch will settle therefore rafters
should slide to accommodate new
roof height (see drawings in left
column)

Rafters & Joists

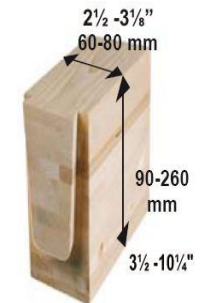
Arunda tenoner will be used for milling of tenons for nice and tight interconnections. Productivity: 5 to 18 tenons per hour.

#	JOISTS	#	RAFTERS	#	SPRINGERS
1.	<p>Joist on springer, flush or offset</p> 	1	<p>Rafter on squared ridge purlin</p> 	1	<p>Springer on through post</p> 
2	<p>Joist on springer at 90°, 45° or any other angle</p> 	2	<p>Rafter on chamfered ridge purlin</p> 	2	<p>Springer on stopped post</p> 
		3	<p>Rafter on plate</p> 		

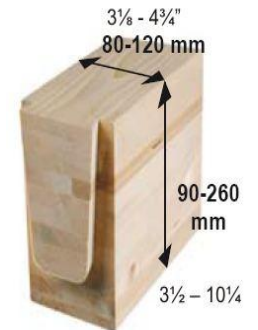
Advantages of Arunda tenoner



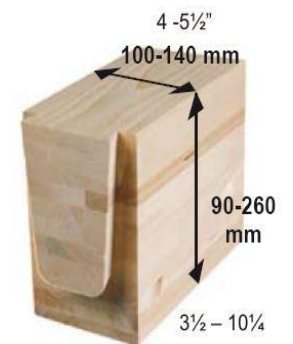
1. **SPEED**
Forming the joint is fast: between 8 and 18 male/female pairs per hour (according to the size and type of joint).
2. **EASE**
The structural members are easily assembled and the beams do not have to be spaced or supported.
3. **PRECISION**
The joint is self-locking: the parts bed together perfectly.
4. **FREEDOM**
Male dovetails can be cut on beams from 80 mm to 180 mm wide and up to 280 mm high. There is no limit to the dimensions of the structural members that take the female dovetail.



Nb. 60



Nb. 80



Nb. 100

5. VERSATILITY

One single model of jig enables you to work on very variable timber sections. Arunda provides the solution to the problem of stocking metal connectors and their availability in various size.

6. TIME SAVING

The male and female dovetails are produced without changing the position of the bit throughout the run.

7. QUALITY

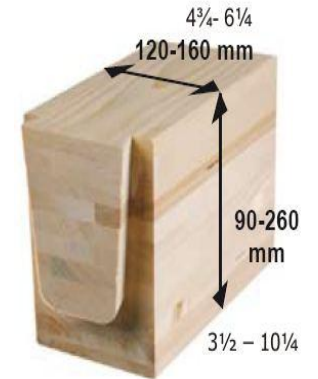
The roof frame returns to its full glory with wood-on-wood assembly.

8. MOBILITY

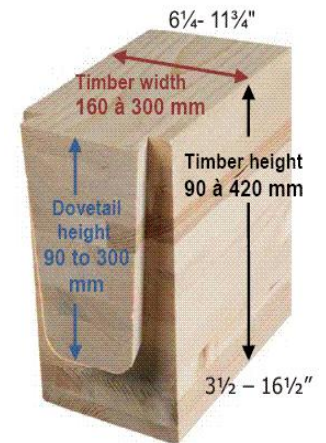
The jigs can be used both in the workshop and on the building or restoration site.

9. ECONOMY

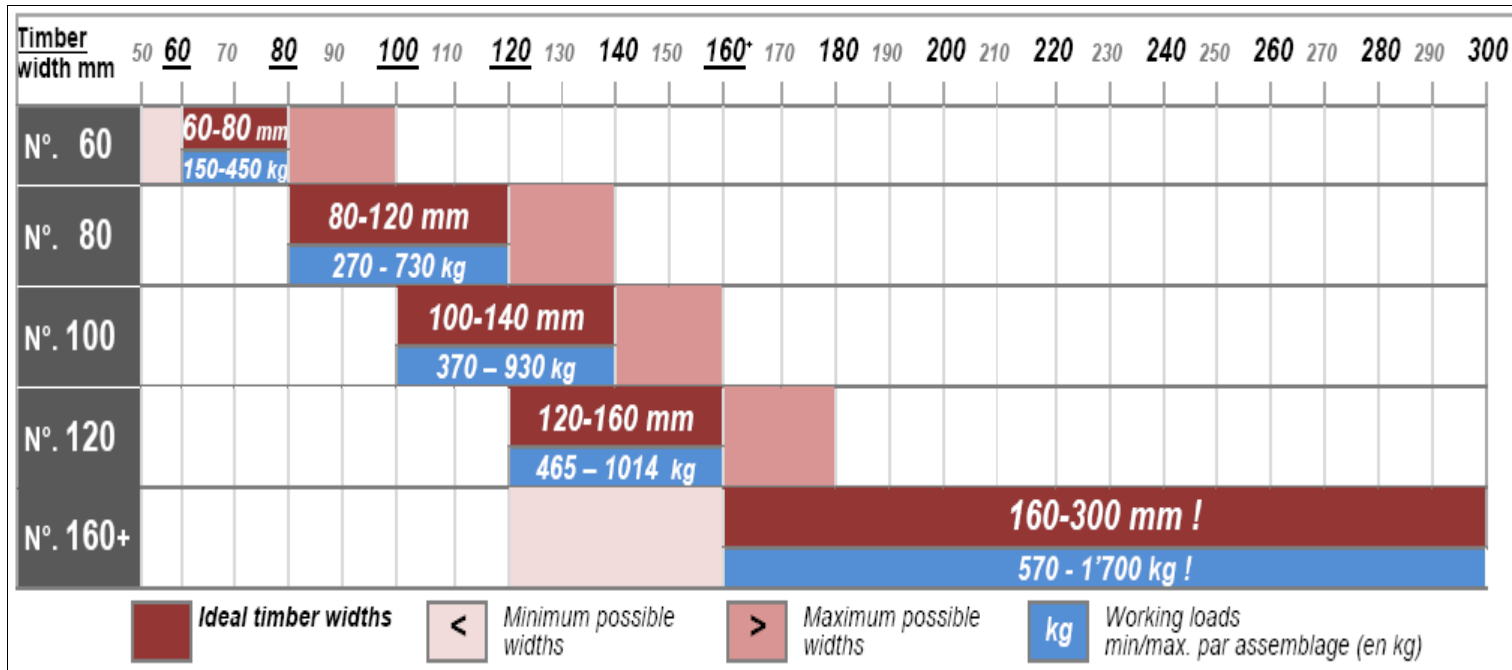
Arunda advantageously replaces metal connectors which are very expensive and take a long time to fit. The investment is one-off and the acquired equipment remains constantly available for assemblies of various sizes.



Nb. 120



Nb. 160+



Logs quantity in wall = 14 , Logs required (26' each) = 117

Assuming that there will be no openings for door & windows (all openings will be cut later when such log shell will be delivered to the customer's site).

This log shell requires following number of logs:

Log type	Q-ty	Notches per log	Log length	Length between notches	Left over hang	Right overhang	In ft	Sum notches
log 1	28	2	26	22	2	2	728	56
log 2	56	2	20	16	2	2	1120	112
log 3	28	2	16	12	2	2	448	56
log 4	28	2	10	6	2	2	280	56
log 5	16	2	8	4	2	2	128	32
Total :							2704	312

Total 26 ft logs to mill:	117	Average notches per log:	2.67
In ft:	3042		
In m:	926.64		
Waste, In ft:	338.00		
Waste, In m	102.46		

Notching data

Time to mill one 10 ¼" (260mm) notch (including positioning of LL-41 vertical mill cutter)	4
Total notches to mill:	312
Average notches per log	2.70

Time used in following table is pretty conservative and is taken from our experience with novice persons working without any help except tractor with forks to deliver logs to/from log lathe. Actual time will depend on other factors :

1. How well log delivery and removing to/from Log Lathe is organized;
2. How nice are logs used for turning (tapered, crooked and knotty logs will require more time)
3. Experience of log lathe operator
4. How well logs are sorted and how much wood layer should be removed from the log (do not mill 8" dowels from 18" logs)
5. Clean up of wood waste

Although some our clients can turn 18-22 logs a day, novice log operator should expect one 26 ft log per hour, especially if there is no conveyors and proper equipment to handle and transport long and heavy logs.

Log processing labor operations	time per log, min	time, h for all logs
Deliver log to the lathe	5	3.90
Load & adjust log on the lathe	5	9.75
Turn log (rough & fine)	15	39.00
Grooving	5	9.75
Notching	11.00	21.45
Remove log	3	5.85
Log labeling	1	1.95
Clean up time	5	3.90
log packaging	1	1.95
Machine service time	2	3.90
Total log processing time	54	106.00
Total logs per 8h workshift	8.8	

Days to mill all logs (8h work shift per day):	13.3
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Work Schedule:

workdays per month	21
Workshift, hours	8
Work shifts per day	1
Total work hours per month	168
Work week days	5
Work week hours	40
Work weeks per year:	50

Employment:

Labor position, wage	\$/hour	q-ty	shifts
Machine operator	\$ 25.00	1	1
Helper	\$ 20.00	1	1
Sales person + Secretary	\$ 20.00	1	1
Owner working as Manager and Sales person	\$ 30.00	1	1
Average hourly rate: \$ 23.75	Total staff:		4
Basic labour cost per month:			\$15,960.00
Basic labour cost per workshift:			\$760.00
Basic labour cost per work hour:			\$95.00

Expenses:

Rent or lease of property for the business	\$3,500.00
Natural Gas	\$250.00
Hydro	\$250.00
Business insurance	\$500.00
Office expenses	\$300.00
Spares & supplies, per month	\$500.00
Communication	\$500.00
Advertisement	\$1,000.00
Sum of expenses per month	\$6,800.00
Sum of expenses per workshift	\$323.81
Sum of expenses per work hour	\$40.48

Power cost:

Generator fuel consumption per hour at 26KWt load, liters	6.8
Tractor average fuel consumption per hour, liters	3
Fuel cost per liter	\$1.50
Fuel cost per month for motorized equipment	\$2,469.60
Generator maintenance per month	\$150.00
Total fuel cost per month:	\$2,619.60
Total fuel cost per workshift:	\$124.74
Total fuel cost per hour:	\$15.59

Depreciation cost:

Depreciation period, years	5
Log milling production line, (LL-41+ Arunda tenoner + delivery + taxes)	\$34,081.60
Used tractor (for log handling)	\$30,000.00
Diesel generator 35KW	\$14,000.00
chain saw	\$500.00
Total equipment cost	\$78,581.60
Depreciation cost per month	\$1,309.69
Depreciation cost per workshift	\$62.37
Depreciation cost per work hour	\$7.80

Business cost:

Cost of operation per month	\$26,689.29
Cost of operation per work day	\$1,270.92
Cost of operation per work shift	\$1,270.92
Cost of operation per work hour	\$158.86
Overhead & unexpected expenses (per hour) 5%	\$7.94
Business cost of operation per work hour (sum)	\$166.681
Business cost of operation per work shift	\$1,334.46
Business cost of operation per work day	\$1,334.46
Business cost of operation per work month	\$28,023.76

Now we can calculate total log processing cost for milling of all logs for the log shell:

“Total processing cost “	=	“Business operating cost per hour”	x	“Total Hours Spent to mill all logs”	
“Total processing cost “	=	\$166.68	x	106	= \$17,668.19

The number **\$17,668.19** can be “converted” to:

- **\$17.82 per sq. ft of log shell**
- **\$5.82 per ln ft of 10¼” dia log (including turning, Swedish Cope, Notches)**
- **\$667.48 per cubic m**
- **\$191.86 per sq m**
- **\$19.08 per ln m of 260mm dia log (including turning, Swedish Cope, Notches)**

To calculate final cost of the project, it is necessary to take in account following expenses which can be variable depending on business location:

- cost of raw materials (raw logs)
- cost of delivery of raw materials
- cost of log shell pre-assembling
- cost of roof system (trusses)
- cost of lumber, rafters and joists
- cost of log shell disassembling
- cost of log shell packaging
- cost delivery of log home kit to the customer's site
- cost of assembling of log home kit on the customer's site
- cost of waste removal

Conclusion

Proposed solution is one of most economically priced solutions in the world intended for semiautomated manufacturing of small quantity log home shells per year. And despite on this fact, the proposed solution allows effective and various log home building styles to be used.

Quality of the products made on the proposed equipment will depend on skills & experience of log lathe operator, log home builder/designer knowledge and experience.

Business using proposed solution can produce log works for about 20-25 \$/sq foot or less if manufacturing is well organized. Labor cost is 50-70% of total cost, therefore if the business uses less than 4 employees or average labor hourly rate is less than \$23.75/h, final price will be proportionally less than \$25/sq foot.