How Dust Collecting System Efficiency Can Be Improved by Using the Duct Optimizer Software and Ecogate System

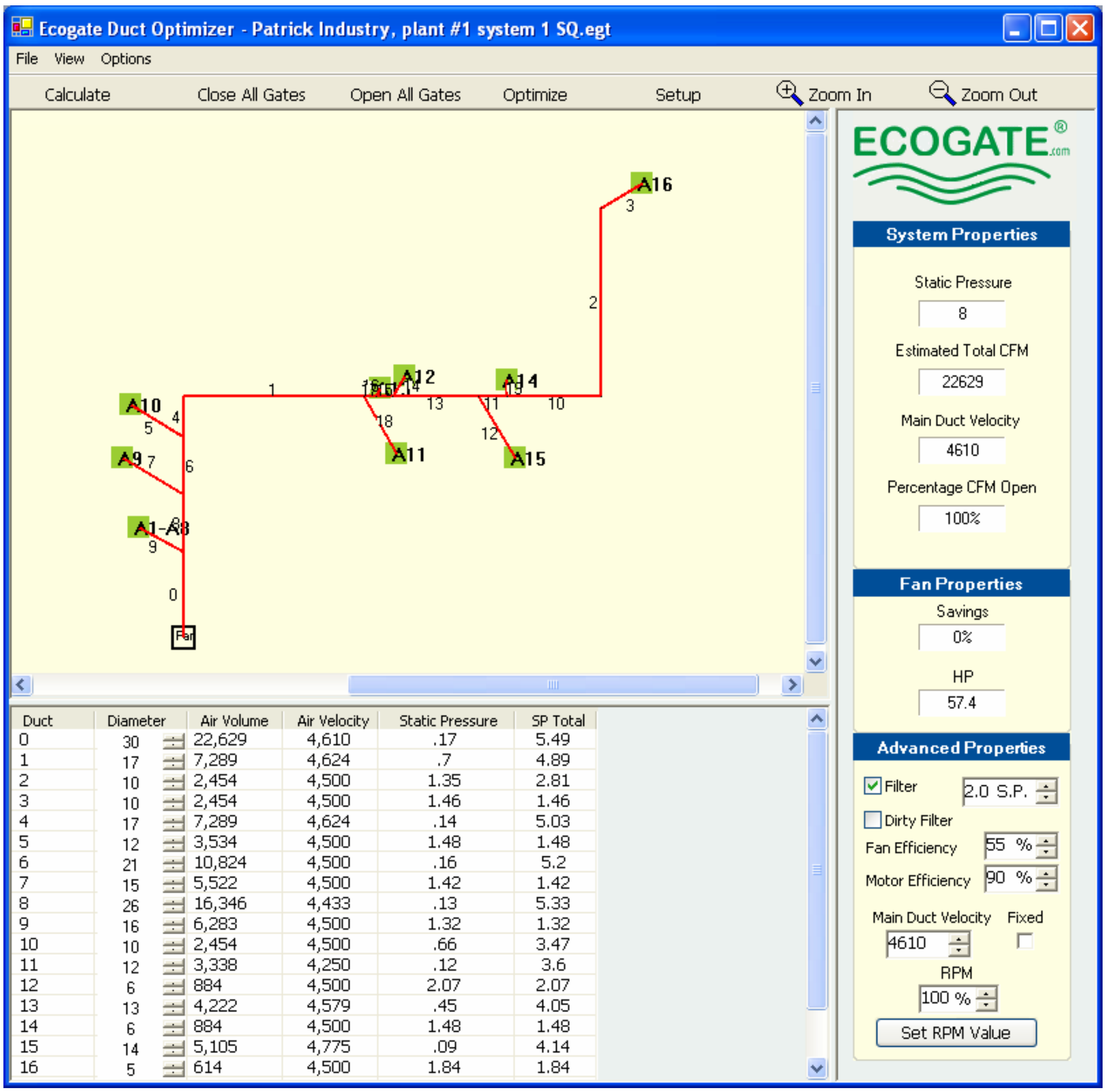
As an example to show how duct layout can be improved using the Ecogate Duct Optimizer software, I chose a system designed for one woodworking company in Czech Republic, Europe. Article will show you how originally proposed system with 57 HP consumption can be improved to system with 16 HP consumption with same or better performance at each workstation.

Ecogate Duct Optimizer software does millions of calculations in designing the optimal layout and ducting diameters for real-world dust collecting systems to improve their efficiency and lower operating cost.

By using negative system, direct drive with high efficiency motors will improve significantly system efficiency.

Automatic gate system and variable speed drive will reduce consumption even further.

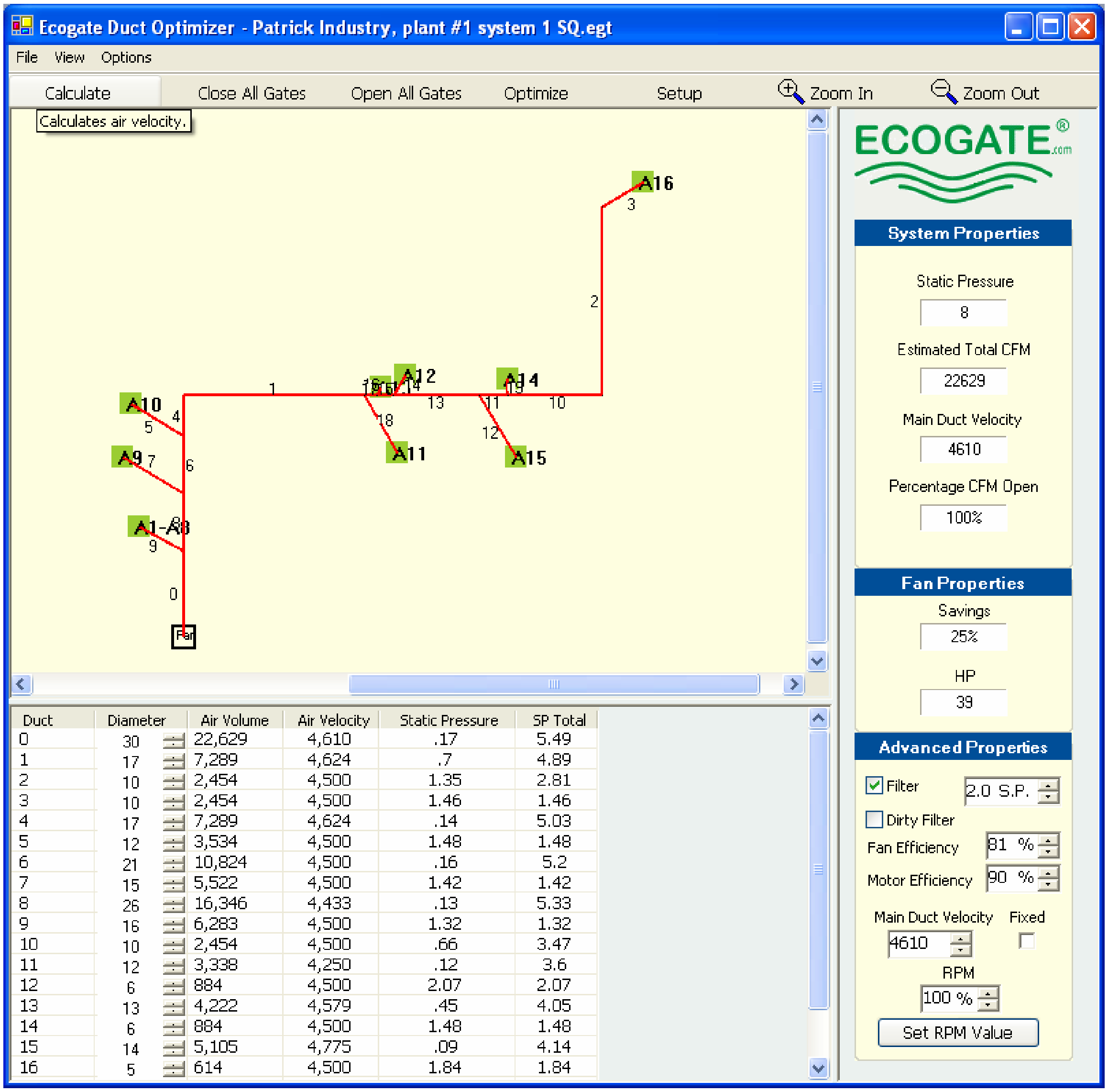
The system was originally designed classically, with mostly right angles by local industrial ventilation company. The system was designed with a dirty-side fan (positive system). The efficiency of the used fan was 55%. A standard efficiency motor with belt-drive was suggested. Fan for a positive system has as much as 8 % lower efficiency than a clean-air fan (negative system), because a more efficient blade shape can be used with a negative system. If a fan with belt drive is used, the losses are 5% higher compare to direct drive. Static pressure losses for this layout are 8 in. water column. In this configuration, the needed motor output is 57.4 HP.



Duct	Diameter	Air Volume	Air Velocity	Static Pressure	SP Total
0	30	22,629	4,610	.17	5.49
1	17	7,289	4,624	.7	4.89
2	10	2,454	4,500	1.35	2.81
3	10	2,454	4,500	1.46	1.46
4	17	7,289	4,624	.14	5.03
5	12	3,534	4,500	1.48	1.48
6	21	10,824	4,500	.16	5.2
7	15	5,522	4,500	1.42	1.42
8	26	16,346	4,433	.13	5.33
9	16	6,283	4,500	1.32	1.32
10	10	2,454	4,500	.66	3.47
11	12	3,338	4,250	.12	3.6
12	6	884	4,500	2.07	2.07
13	13	4,222	4,579	.45	4.05
14	6	884	4,500	1.48	1.48
15	14	5,105	4,775	.09	4.14
16	5	614	4,500	1.84	1.84

Picture 1: non-optimized layout, positive system, belt drive, necessary power is 57.4 HP, static pressure losses 8" water.

This version uses the same (not optimized) layout, but a fan with a higher efficiency (87%) is used, and the required motor output is now only 39 HP.

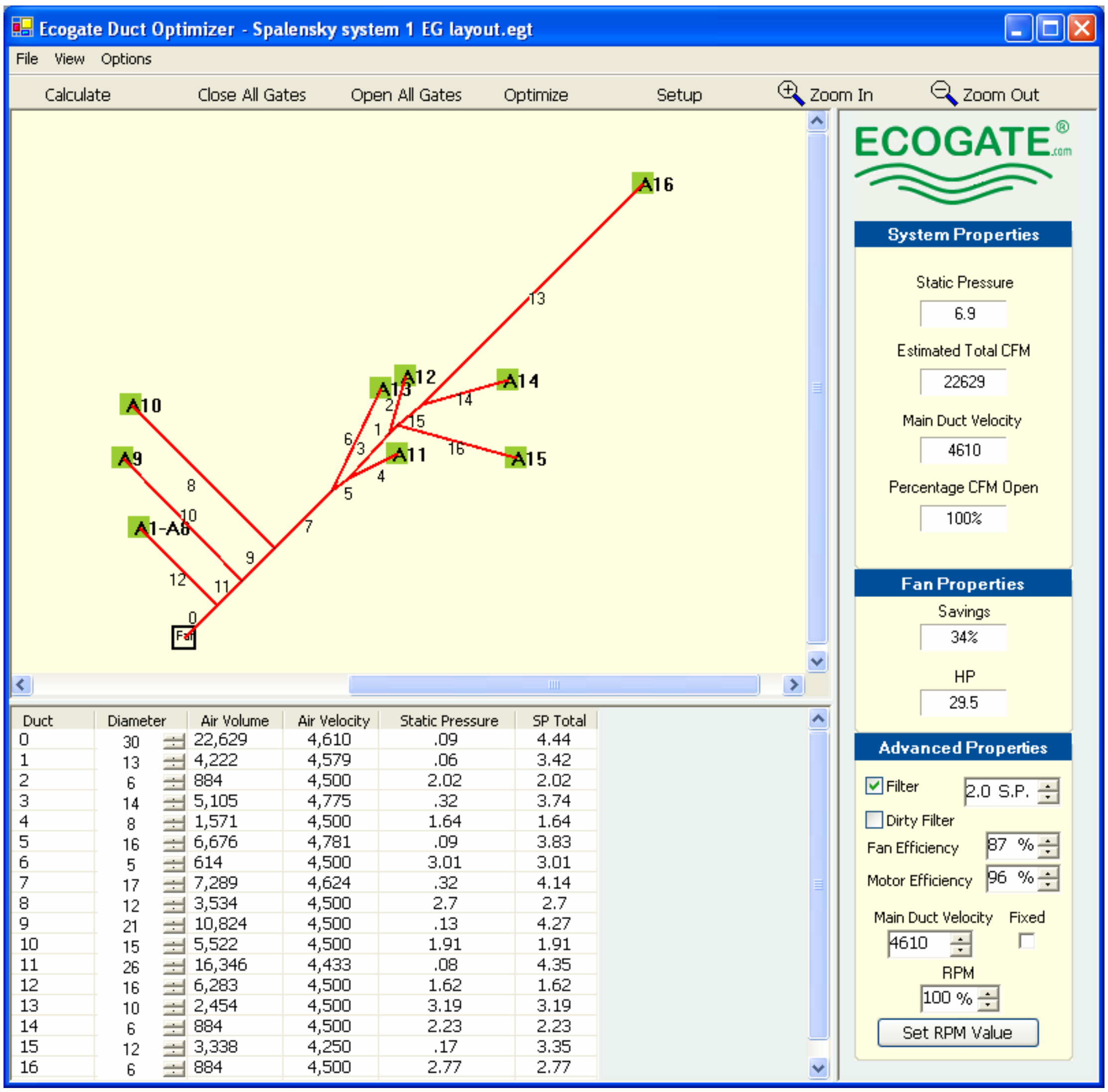


Picture 2: non-optimized layout, positive system with fan with better efficiency (in comparison to picture 1), belt drive, and necessary power is 39 HP, static pressure losses 8" water.

This picture shows the optimized layout for the lowest Static Pressure losses calculated by Duct Optimizer. What is improved?

1. The design uses the shortest possible way to the furthest machine (A16), and the other machines are also connected using the shortest possible way to the main duct. Due to these adjustments, the Static Pressure losses of the system decreased from 8 to 6.9 inches water column.
2. A clean-air fan (negative system) with an efficiency of 87% is used.
3. A premium efficiency motor with direct drive is used (efficiency is 6% better compared to a standard efficiency motor with belt drive).

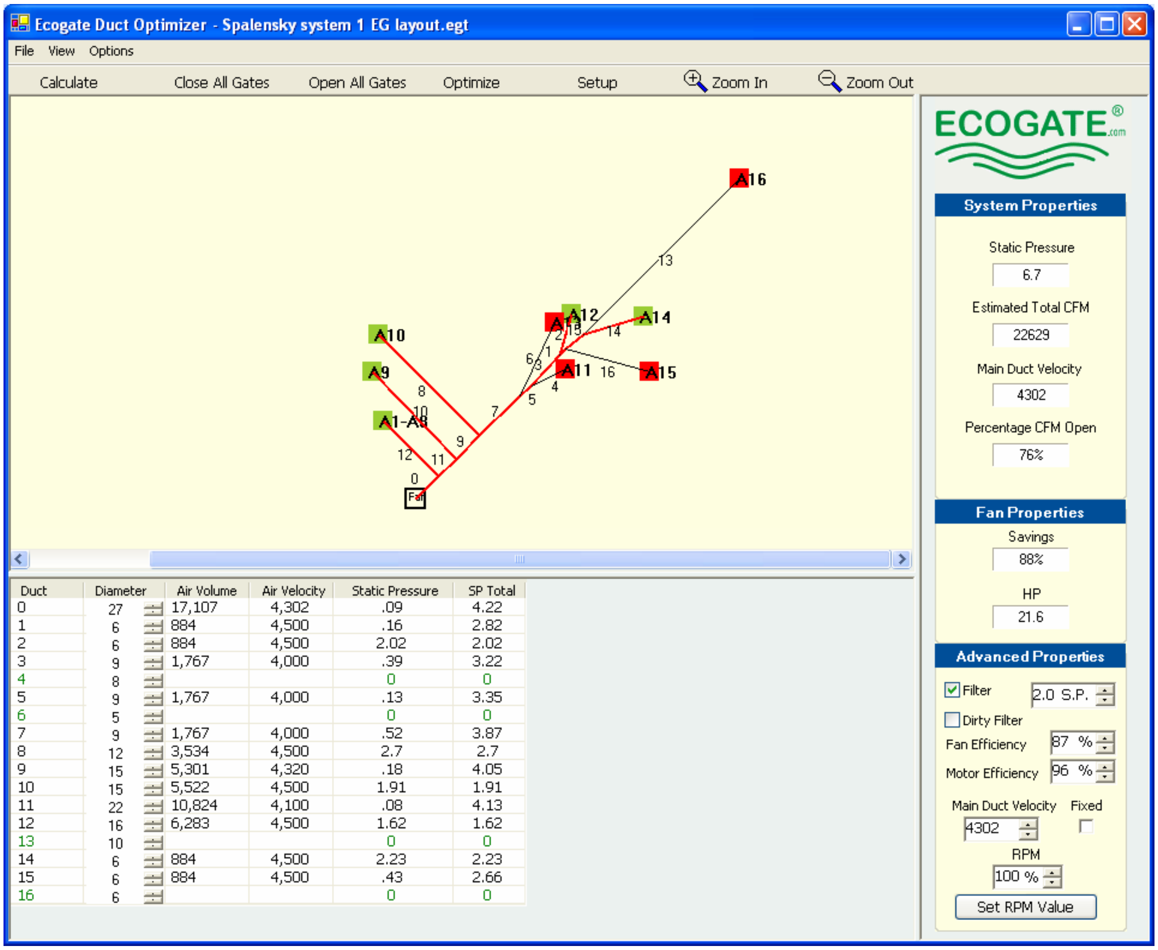
The result is that the required motor output is only 29.5 HP in contrast with 57 HP in the worst design (a 93% improvement).



Duct	Diameter	Air Volume	Air Velocity	Static Pressure	SP Total
0	30	22,629	4,610	.09	4.44
1	13	4,222	4,579	.06	3.42
2	6	884	4,500	2.02	2.02
3	14	5,105	4,775	.32	3.74
4	8	1,571	4,500	1.64	1.64
5	16	6,676	4,781	.09	3.83
6	5	614	4,500	3.01	3.01
7	17	7,289	4,624	.32	4.14
8	12	3,534	4,500	2.7	2.7
9	21	10,824	4,500	.13	4.27
10	15	5,522	4,500	1.91	1.91
11	26	16,346	4,433	.08	4.35
12	16	6,283	4,500	1.62	1.62
13	10	2,454	4,500	3.19	3.19
14	6	884	4,500	2.23	2.23
15	12	3,338	4,250	.17	3.35
16	6	884	4,500	2.77	2.77

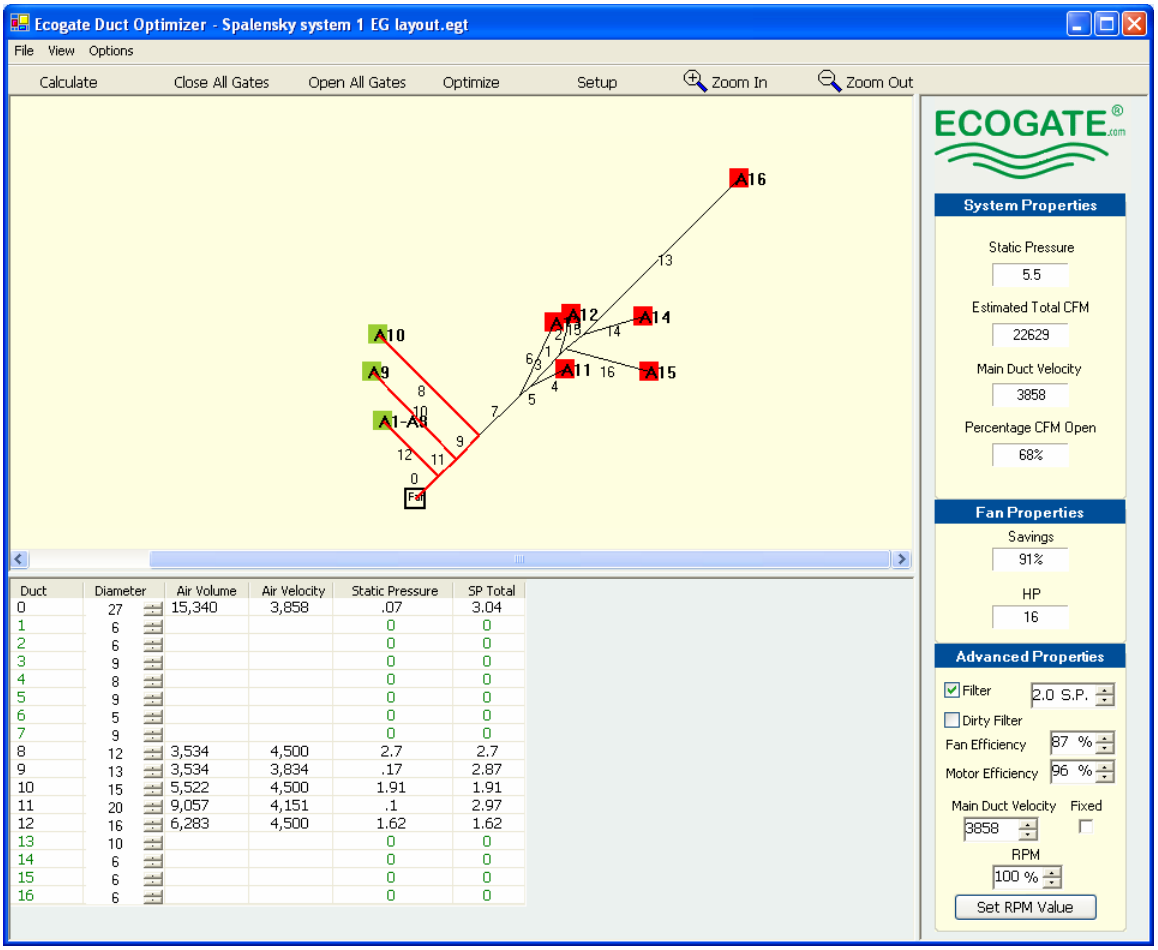
Picture 3: optimized layout, positive system with fan with better efficiency 87%, direct drive with premium efficiency motor (losses reduced by 6%), and necessary power is 39 HP, static pressure losses 6.9" water.

Another way to increase system efficiency is by using electronically controlled gates and variable speed drive to control RPM of the fan motor (Ecogate MASTER System). The picture below shows an operating point with 76% of the workstations working. At this point, only 21.6 HP is needed (the rest of the configuration remained the same as in the previous picture).



Picture 4: optimized layout, positive system with fan with better efficiency 87%, direct drive with premium efficiency motor (losses reduced by 6%), automatic gate system and variable speed drive to control fan motor is added, 76% of workstations are working (red square means workstation is not cutting material) necessary power is only 21.6 HP, static pressure losses 6.7" water.

This picture shows an example of another operating point of system with gates and variable speed drive where 68 % of the workstations are working (a green square represents an operating workstation, a red square a workstation that is not operating). The required fan output is now only 16 HP.



Picture 5: optimized layout, positive system with fan with better efficiency 87%, direct drive with premium efficiency motor (losses reduced by 6%), automatic gate system and variable speed drive to control fan motor is added, 68% of workstations are working (red square means workstation is not cutting material) necessary power is only 16 HP, static pressure losses 5.5" water.

As you can see form this real system design, the efficiency of a system that required 57 HP of permanent output can be reduced to the extent where if 68 % of the workstations are running, the required output is reduced to 16 HP. Is this worth the effort?

One look at a table of calculated operating costs answers this question. With the California electricity price of 16 cents per kWh, the operating costs are $200,000 lower at one shift), $400,000 lower at two shifts, and $860,000 with 24 hours a day operation over system life of 20 years. This extreme example of system operating cost reduction, but annual operating cost is reduced for example at two shifts, electricity cost $0.12/kWh from $21,720 to $5,970. This is relatively small system with several workstations only. This is definitely worth the effort with optimized system design. Also, the cost of the ducting in the optimized layout is reduced, as well as its installation cost.

Comparing designs

Version/Picture #	**1**	**2**	**3**	**4**	**5**
	Original design	Better efficiency fan	Negative system, direct drive, optimal layout	Same as a #3 + gate system + variable speed drive	Same as a #4, 68% of workstations working
Consumption HP	**57**	**39**	**29.5**	**21.6**	**16**
Consumption kW	42.6	29.2	22.1	16.1	12.0

Work hours, 1 shift	2080
Work hours, 2 shifts	4160
Work hours, 3 shift3	8760

Consumption, 1 shift (kWh)	88,624	60,637	45,867	33,584	24,877
Consumption, 2 shifts (kWh)	177,247	121,274	91,733	67,167	49,754
Consumption, 3 shifts (kWh)	373,242	255,376	193,169	141,439	104,770

Annual electricity cost at	**$0.08**	**per kWh**			
Yearly electricity cost, 1 Sh.	$7,090	$4,851	$3,669	$2,687	$1,990
Yearly electricity cost, 2 Sh.	$14,180	$9,702	$7,339	$5,373	$3,980
Yearly electricity cost, 3 Sh.	$29,859	$20,430	$15,454	$11,315	$8,382

Annual electricity cost at	**$0.12**	**per kWh**			
Yearly electricity cost, 1 Sh.	$10,635	$7,276	$5,504	$4,030	$2,985
Yearly electricity cost, 2 Sh.	$21,270	$14,553	$11,008	$8,060	$5,970
Yearly electricity cost, 3 Sh.	$44,789	$30,645	$23,180	$16,973	$12,572

Annual electricity cost at	**$0.16**	**per kWh**			
Yearly electricity cost, 1 Sh.	$14,180	$9,702	$7,339	$5,373	$3,980
Yearly electricity cost, 2 Sh.	$28,360	$19,404	$14,677	$10,747	$7,961
Yearly electricity cost, 3 Sh.	$59,719	$40,860	$30,907	$22,630	$16,763

Savings over 20 year system life	100%	$89,556	$136,822	$176,128	$203,990
(at 3 shifts and $0.16 per kWh)	100%	$179,113	$273,645	$352,255	$407,980
	100%	$377,171	$576,233	$741,769	$859,111

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