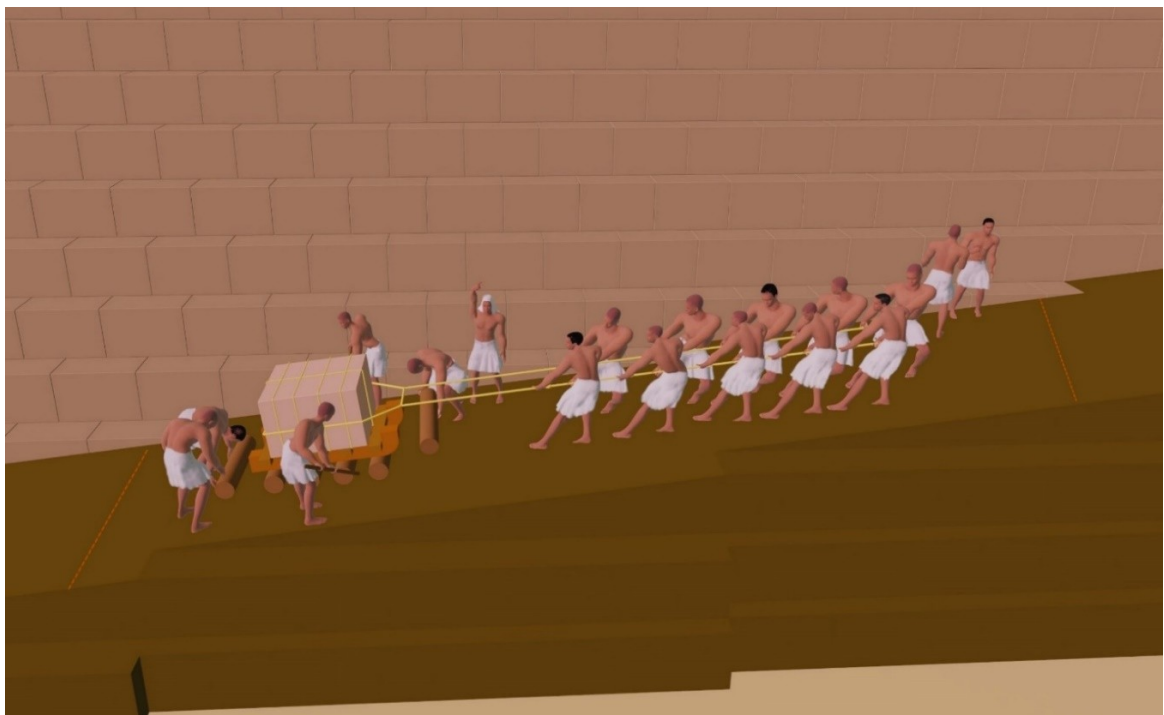


Table 1 - Workforce

by Rudolf Volz

Up No.	The Up Number represents the specific level of the total pyramid counted from the bottom to the top (1 - 210).
Down No.	The Down Number represents specific the level of the step pyramid counted backwards from the bottom to the top (209 - 1). Up_No. = 210 – Down_No.
Total lanes	Number of lanes that reach the corresponding level.
Delivery lanes	The blocks were transported on the delivery lanes up to the corresponding level. This quantity is the key factor that determines the production capacity of the entire project. The capacity is limited by the total number of lanes and the number of workers. Since the way back was a separate lane, the following condition must hold: $\text{Delivery_lanes} \leq \text{Total_lanes} - 1$
Max. rate	The maximal rate represents the number of produced and installed blocks per day for 3 months during the Nile flood. Each lane can deliver 15 blocks per hour, or 180 blocks per day. $\text{Maximal_rate} = \text{Delivery_lanes} * 180$ Then the numbers Delivery_lanes and Maximal_rate have to be reduced so that the corresponding number Workers_maximum does not exceed 20,000.
Min. rate	The minimal rate represents the number of installed blocks per day during the other 9 months of the year. There were about 10,000 workers available during this time. In the bottom half of the pyramid there is the relationship: $\text{Minimal_rate} = \text{Maximal_rate} / 2$



Workers tow	<p>Number of workers during the Nile flood who towed the blocks on the ramps up to the corresponding level. This is calculated as follows: $W_1 = 2 * \text{Delivery_lanes} * (3 + 0.5 * \text{Up_No.} + \text{Down_No.}/44) * 1.2 * 18$ On each lane, the tow teams were spaced 11 block lengths apart what is indicated by the orange lines. This corresponds to 2 levels and therefore, the number of tow teams can be expressed by $0.5 * \text{Up_No.}$ At the bottom of the pyramid, 3 towing teams were waiting to be deployed. Statistically, on the top level of the pyramid there were $\text{Down_No.}/44$ teams to transport their block to the designated location. The factor 1.2 expresses the additional proportion of workers on the way back what corresponds to $20/120 \cong 17\%$. Each tow team consisted of 18 workers. The factor 2 stands for the two shifts in one day.</p>
Workers quarries	<p>Workers which worked in the quarries during the Nile flood. They had to produce, smooth, store and install blocks. Also, they had to transport the blocks next to but not onto the pyramid. Each block required 6 days of work. $W_2 = 6 * \text{Maximal_rate}$</p>
Workers others	<p>Workers which neither towed blocks nor worked in the quarries during the Nile flood. $W_3 = 0.42 * (W_1 + W_2)$ This term refers to the extra workers who built ramps. This is proportional to the workers who towed blocks or worked in the quarries. The factor 0.42 expresses this proportion what corresponds to $42/142 \cong 30\%$ of all workers. $W_4 = 0.15 * (W_1 + W_2 + W_3)$ $= 0.15 * ((W_1 + W_2) + 0.42 * (W_1 + W_2))$ $= 0.15 * 1.42 * (W_1 + W_2)$ This term refers to the extra workers who prepared food and organized things. The factor 0.15 corresponds to $15/115 \cong 13\%$ of all employees.</p>
Workers maximum	<p>Total number of workers during the Nile flood. $W_5 = W_1 + W_2 + W_3 + W_4$ $= (W_1 + W_2) + 0.42 * (W_1 + W_2) + 0.15 * 1.42 * (W_1 + W_2)$ $= (1 + 0.42 + 0.15 * 1.42) * (W_1 + W_2)$ $= 1.15 * 1.42 * (W_1 + W_2) = \mathbf{1.633 * (W_1 + W_2)}$</p>
Workers minimum	<p>Total number of workers outside the Nile flood. $W_6 = W_5 * \text{Minimal_rate} / \text{Maximal_rate}$</p>

Up No.	Down No.	Total lanes	Delivery lanes	Max. rate	Min. rate	Workers tow	Workers quarries	Workers others	Workers maximum	Workers minimum
1	209	10	8.46	1,523	761	3,015	9,137	7,692	19,844	9,922
2	208	10	8.33	1,499	750	3,141	8,996	7,683	19,820	9,910
3	207	10	8.23	1,481	741	3,273	8,888	7,698	19,859	9,929
4	206	10	8.11	1,460	730	3,392	8,759	7,691	19,842	9,921
5	205	9	7.99	1,438	719	3,507	8,629	7,682	19,818	9,909
6	204	9	7.87	1,417	708	3,616	8,500	7,669	19,785	9,893
7	203	9	7.76	1,397	698	3,726	8,381	7,663	19,770	9,885
8	202	9	7.65	1,377	689	3,831	8,262	7,655	19,747	9,874
9	201	9	7.55	1,359	680	3,936	8,154	7,653	19,743	9,872
10	200	9	7.46	1,343	671	4,043	8,057	7,659	19,759	9,880

Table 1 - Workforce / 3

Up No.	Down No.	Total lanes	Delivery lanes	Max. rate	Min. rate	Workers tow	Workers quarries	Workers others	Workers maximum	Workers minimum
11	199	9	7.37	1,327	663	4,146	7,960	7,663	19,769	9,884
12	198	9	7.28	1,310	655	4,246	7,862	7,664	19,773	9,886
13	197	9	7.18	1,292	646	4,335	7,754	7,653	19,743	9,871
14	196	9	7.09	1,276	638	4,427	7,657	7,649	19,734	9,867
15	195	9	7.01	1,262	631	4,522	7,571	7,655	19,747	9,874
16	194	9	6.94	1,249	625	4,620	7,495	7,669	19,784	9,892
17	193	9	6.90	1,242	621	4,735	7,452	7,715	19,902	9,951
18	192	9	6.84	1,231	616	4,835	7,387	7,737	19,959	9,980
19	191	9	6.77	1,219	609	4,925	7,312	7,746	19,983	9,991
20	190	9	6.69	1,204	602	5,005	7,225	7,742	19,972	9,986
21	189	9	6.60	1,188	594	5,074	7,128	7,724	19,926	9,963
22	188	9	6.51	1,172	586	5,139	7,031	7,703	19,873	9,937
23	187	9	6.42	1,156	578	5,200	6,934	7,681	19,814	9,907
24	186	9	6.34	1,141	571	5,266	6,847	7,668	19,781	9,891
25	185	9	6.26	1,127	563	5,329	6,761	7,653	19,742	9,871
26	184	9	6.19	1,114	557	5,397	6,685	7,648	19,730	9,865
27	183	9	6.13	1,103	552	5,471	6,620	7,654	19,745	9,873
28	182	9	6.08	1,094	547	5,552	6,566	7,671	19,789	9,894
29	181	9	6.02	1,084	542	5,621	6,502	7,674	19,796	9,898
30	180	9	5.97	1,075	537	5,697	6,448	7,688	19,833	9,916
31	179	9	5.91	1,064	532	5,762	6,383	7,688	19,832	9,916
32	178	9	5.86	1,055	527	5,834	6,329	7,699	19,862	9,931
33	177	8	5.78	1,040	520	5,874	6,242	7,669	19,785	9,893
34	176	8	5.73	1,031	516	5,941	6,188	7,678	19,807	9,904
35	175	8	5.68	1,022	511	6,006	6,134	7,685	19,825	9,913
36	174	7	5.62	1,012	506	6,059	6,070	7,677	19,805	9,903
37	173	7	5.57	1,003	501	6,120	6,016	7,682	19,817	9,908
38	172	7	5.51	992	496	6,167	5,951	7,671	19,789	9,894
39	171	7	5.46	983	491	6,224	5,897	7,672	19,793	9,896
40	170	7	5.40	972	486	6,267	5,832	7,659	19,757	9,879
41	169	7	5.37	967	483	6,343	5,800	7,686	19,828	9,914
42	168	7	5.34	961	481	6,417	5,767	7,713	19,897	9,949
43	(50%)	7	5.31	956	478	6,491	5,735	7,739	19,964	9,982
44	166	7	5.27	949	474	6,551	5,692	7,749	19,991	9,996
45	165	7	5.22	940	470	6,596	5,638	7,744	19,977	9,989
46	164	7	5.17	931	465	6,639	5,584	7,737	19,960	9,980
47	163	7	5.12	922	461	6,681	5,530	7,729	19,940	9,970
48	162	7	5.07	913	456	6,720	5,476	7,720	19,916	9,958
49	161	6	5.02	904	452	6,757	5,422	7,709	19,888	9,944
50	160	6	4.98	896	448	6,806	5,378	7,713	19,897	9,949
51	159	6	4.94	889	445	6,853	5,335	7,715	19,904	9,952
52	158	6	4.90	882	441	6,899	5,292	7,717	19,908	9,954
53	157	6	4.85	873	437	6,928	5,238	7,701	19,868	9,934
54	156	6	4.82	868	434	6,985	5,206	7,717	19,907	9,954
55	155	6	4.78	860	430	7,026	5,162	7,715	19,903	9,951
56	154	6	4.75	855	428	7,079	5,130	7,729	19,938	9,969
57	153	6	4.71	848	424	7,117	5,087	7,725	19,929	9,964
58	152	6	4.68	842	421	7,168	5,054	7,737	19,959	9,980
59	151	6	4.64	835	418	7,202	5,011	7,731	19,945	9,972
60	150	6	4.60	828	414	7,235	4,968	7,725	19,928	9,964

Table 1 - Workforce / 4

Up No.	Down No.	Total lanes	Delivery lanes	Max. rate	Min. rate	Workers tow	Workers quarries	Workers others	Workers maximum	Workers minimum
61	149	6	4.56	821	410	7,266	4,925	7,717	19,908	9,954
62	148	6	4.52	814	407	7,296	4,882	7,708	19,886	9,943
63	147	6	4.49	808	404	7,340	4,849	7,716	19,905	9,952
64	(10 yrs)	6	4.45	801	401	7,366	4,806	7,705	19,877	9,939
65	145	6	4.41	794	397	7,391	4,763	7,693	19,847	9,924
66	144	6	4.37	787	393	7,414	4,720	7,681	19,814	9,907
67	143	6	4.34	781	391	7,453	4,687	7,685	19,824	9,912
68	142	6	4.31	776	388	7,490	4,655	7,688	19,832	9,916
69	141	6	4.28	770	385	7,526	4,622	7,690	19,839	9,919
70	140	6	4.25	765	383	7,561	4,590	7,692	19,843	9,921
71	139	6	4.22	760	380	7,595	4,558	7,692	19,845	9,922
72	138	6	4.20	756	378	7,645	4,536	7,711	19,892	9,946
73	137	6	4.17	751	375	7,677	4,504	7,710	19,890	9,945
74	136	6	4.14	745	373	7,707	4,471	7,709	19,887	9,943
75	135	6	4.11	740	370	7,736	4,439	7,706	19,881	9,940
76	134	6	4.08	734	367	7,763	4,406	7,703	19,873	9,937
77	133	6	4.05	729	365	7,790	4,374	7,700	19,863	9,932
78	132	6	4.03	725	363	7,834	4,352	7,714	19,901	9,950
79	131	6	4.01	722	361	7,878	4,331	7,728	19,937	9,969
80	130	6	3.98	716	358	7,901	4,298	7,722	19,922	9,961
81	129	6	3.95	711	356	7,923	4,266	7,716	19,905	9,952
82	128	6	3.92	706	353	7,944	4,234	7,708	19,886	9,943
83	127	6	3.89	700	350	7,963	4,201	7,700	19,864	9,932
84	126	6	3.86	695	347	7,981	4,169	7,691	19,841	9,921
85	125	6	3.83	689	345	7,998	4,136	7,681	19,816	9,908
86	124	6	3.81	686	343	8,035	4,115	7,691	19,841	9,920
87	123	6	3.79	682	341	8,071	4,093	7,700	19,864	9,932
88	122	6	3.77	679	339	8,106	4,072	7,709	19,886	9,943
89	121	5	3.75	675	338	8,141	4,050	7,717	19,907	9,954
90	120	5	3.72	670	335	8,152	4,018	7,703	19,873	9,937
91	119	5	3.70	666	333	8,185	3,996	7,710	19,891	9,945
92	118	5	3.67	661	330	8,194	3,964	7,696	19,853	9,927
93	117	5	3.65	657	329	8,224	3,942	7,701	19,868	9,934
94	116	5	3.63	653	327	8,254	3,920	7,707	19,881	9,941
95	115	5	3.61	650	325	8,283	3,899	7,711	19,893	9,947
96	114	5	3.58	644	322	8,288	3,866	7,694	19,848	9,924
97	113	5	3.56	641	320	8,315	3,845	7,697	19,857	9,929
98	112	5	3.54	637	319	8,342	3,823	7,700	19,865	9,932
99	111	5	3.52	634	317	8,367	3,802	7,703	19,871	9,936
100	110	5	3.50	630	315	8,392	3,780	7,705	19,876	9,938
101	109	5	3.48	626	313	8,415	3,758	7,706	19,880	9,940
102	108	5	3.45	621	311	8,414	3,726	7,685	19,825	9,912
103	107	5	3.42	616	308	8,411	3,694	7,662	19,767	9,884
104	106	5	3.40	612	306	8,432	3,672	7,662	19,766	9,883
105	(Median)	5	3.39	610	305	8,477	3,661	7,684	19,822	9,911
106	104	5	3.38	608	304	8,522	3,650	7,705	19,878	9,939
107	103	5	3.37	607	303	8,566	3,640	7,726	19,932	9,966
108	102	5	3.35	603	302	8,585	3,618	7,724	19,927	9,963
109	101	5	3.33	599	300	8,602	3,596	7,722	19,920	9,960
110	100	5	3.31	596	298	8,619	3,575	7,718	19,912	9,956

Table 1 - Workforce / 5

Up No.	Down No.	Total lanes	Delivery lanes	Max. rate	Min. rate	Workers tow	Workers quarries	Workers others	Workers maximum	Workers minimum
111	99	5	3.29	592	296	8,634	3,553	7,715	19,902	9,951
112	(90%)	5	3.27	589	294	8,649	3,532	7,710	19,891	9,946
113	97	5	3.25	585	293	8,663	3,510	7,706	19,879	9,940
114	96	5	3.23	581	291	8,677	3,488	7,700	19,865	9,933
115	95	5	3.22	580	290	8,716	3,478	7,719	19,912	9,956
116	94	4	3.20	576	286	8,728	3,456	7,712	19,896	9,879
117	93	4	3.00	540	284	8,244	3,240	7,270	18,754	9,863
118	92	4	3.00	540	283	8,306	3,240	7,309	18,855	9,881
119	91	4	3.00	540	282	8,368	3,240	7,348	18,956	9,899
120	90	4	3.00	540	280	8,430	3,240	7,387	19,057	9,881
121	89	4	3.00	540	279	8,492	3,240	7,426	19,158	9,898
122	88	4	3.00	540	278	8,554	3,240	7,465	19,259	9,915
123	87	4	3.00	540	276	8,615	3,240	7,505	19,360	9,895
124	86	4	3.00	540	275	8,677	3,240	7,544	19,461	9,911
125	85	4	3.00	540	273	8,739	3,240	7,583	19,562	9,890
126	84	4	3.00	540	272	8,801	3,240	7,622	19,663	9,904
127	83	3	3.00	540	271	8,863	3,240	7,661	19,764	9,919
128	82	3	2.20	396	270	6,545	2,376	5,647	14,568	9,932
129	81	3	2.19	394	269	6,560	2,365	5,650	14,575	9,946
130	80	3	2.18	392	268	6,575	2,354	5,652	14,582	9,959
131	79	3	2.17	391	267	6,590	2,344	5,655	14,588	9,972
132	78	3	2.16	389	266	6,604	2,333	5,657	14,594	9,984
133	77	3	2.15	387	262	6,618	2,322	5,659	14,599	9,883
134	76	3	2.14	385	261	6,631	2,311	5,660	14,603	9,894
135	75	3	2.13	383	260	6,644	2,300	5,662	14,606	9,905
136	74	3	2.12	382	259	6,656	2,290	5,663	14,609	9,915
137	73	3	2.11	380	258	6,669	2,279	5,664	14,611	9,925
138	72	3	2.10	378	257	6,680	2,268	5,664	14,613	9,935
139	71	3	2.11	380	257	6,756	2,279	5,719	14,753	9,983
140	70	3	2.09	376	256	6,735	2,257	5,692	14,684	9,992
141	69	3	2.08	374	252	6,745	2,246	5,692	14,683	9,883
142	68	3	2.07	373	250	6,756	2,236	5,691	14,683	9,851
143	67	3	2.06	371	250	6,765	2,225	5,691	14,681	9,898
144	66	3	2.05	369	249	6,775	2,214	5,690	14,679	9,905
145	65	3	2.04	367	248	6,784	2,203	5,689	14,676	9,912
146	64	3	2.03	365	246	6,792	2,192	5,687	14,672	9,878
147	63	3	2.02	364	245	6,801	2,182	5,686	14,668	9,884
148	62	3	2.01	362	244	6,808	2,171	5,684	14,663	9,889
149	61	3	2.00	360	243	6,816	2,160	5,682	14,657	9,894
150	60	3	1.99	358	242	6,823	2,149	5,679	14,651	9,898
151	59	3	1.98	356	241	6,829	2,138	5,677	14,644	9,903
152	58	3	1.97	355	240	6,835	2,128	5,674	14,637	9,906
153	57	3	1.96	353	238	6,841	2,117	5,670	14,628	9,868
154	56	3	1.95	351	237	6,846	2,106	5,667	14,619	9,871
155	55	3	1.94	349	235	6,851	2,095	5,663	14,610	9,832
156	54	3	1.93	347	233	6,856	2,084	5,659	14,599	9,792
157	53	3	1.92	346	231	6,860	2,074	5,655	14,588	9,751
158	52	3	1.91	344	229	6,863	2,063	5,650	14,577	9,709
159	51	3	1.90	342	228	6,867	2,052	5,646	14,564	9,710
160	50	3	1.89	340	227	6,870	2,041	5,641	14,551	9,709

