WHY HYDRAULIC ELEVATORS ARE SO POPULAR

by Dr. Ferhat Çelik and Dr. Banu Korbahti

Hydraulic elevators dominated the elevator market for 50 years – until the beginning of the 21st century. With the emergence of machine-room-less (MRL) traction elevators in 1995, hydraulic elevators began dealing with increased competition. Nevertheless, fluid-driven systems have their distinct advantages, such as low maintenance cost due to wear-free driving components, flexibility of car and machine-room design, safety features, and easy and cost-effective installations.

The room-saving properties of MRLs initially generated increasing numbers of MRL applications. However, this shouldn't be interpreted as a decreasing market for hydraulic elevators, since the fact is that hydraulic control-valve production is increasing yearly. As hydraulic elevators and their advantages become better known in developing countries, the increasing trend to MRLs is expected to level off. The future of elevator systems may become certain as their advantages and genuine costs become public.

This article presents statistical information on the actual elevator market trend for low-rise buildings.

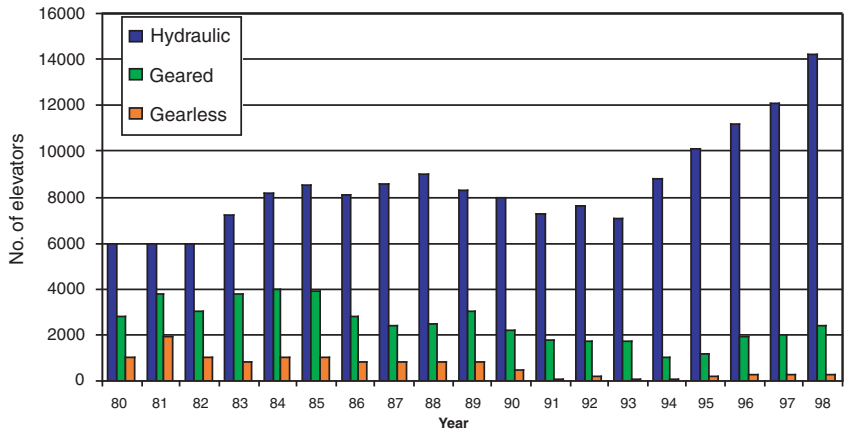

Figure 1: Elevator production between 1980 and 1998 in NEII member companies[1]

Introduction

Since the 19th century, cable elevators and water hydraulics were used for vertical transportation. In the 1950s, oil-hydraulic elevator solutions were introduced in both the U.S. and Germany at about the same time, and quickly became popular. Initially, hydraulic elevators were used for the vertical transportation of general freight (excluding passengers) and, due to improvements in valve controls over time and economic reasons, hydraulic elevators started being used for transporting passengers. The economic reasons that favored hydraulic versus traction included the cost of hoistway construction, equipment and labor required for installation.

According to the statistics by the National Elevator Industry, Inc. (NEII), companies produced more hydraulic elevators than either geared or gearless traction elevators in the 1970s. In 1973, hydraulic elevator production overtook the total traction production, more than doubling that of traction elevators each year since the mid 1980s. In 1986, approximately 70% of the all elevator units sold for new buildings in the U.S. were of the hydraulic type. Hydraulic elevator production until the year 2000 remained at three to four times that of traction elevators. These statistics only represent those of NEII member companies. Certainly, many more hydraulic elevators have been installed by non-NEII member companies throughout these years.[1]

Since 1995, major elevator companies have released a new drive system, directly targeting the low- and medium-rise market. The new system is known as the MRL. It implements permanent-magnet synchronous (PMS) motor technology that eliminates the speed-reducing mechanism, resulting in the reduction of the weight and the size of the traction machine. With this solution, the machine (and in some cases, the control) are placed inside the shaft, thereby eliminating the need for a separate machine room. Hence, architectural flexibility of the building is improved. The energy saving is achieved by eliminating power consumption from the worm-gear transmission. Among its further advantages, compactness, lubrication-free design and high torque at low speed can be counted. Although using permanent-magnet materials increases the manufacturing costs of the motor, the elimination of the gear transmission mechanism is said to balance the increase.[2]

On the other hand, the cost of traction MRLs is still higher than that of hydraulic units. It is believed that in time, the manufacturing volume of MRLs will increase and their cost will go down, increasing the competitiveness of MRLs.[1]

However, hydraulically operated elevators have established a very strong market position with their high level of safety, easy installation features and service-free running characteristics. Figure 2 shows yearly percentage repairs of hydraulic control valves (received from customers) at Blain Hydraulics GmbH, which is a major control-valve manufacturer. It can be seen that the total repairs received is, at most, 0.087% of the total valves in operation (350,000) in 2003, 0.037% of which are attributed to

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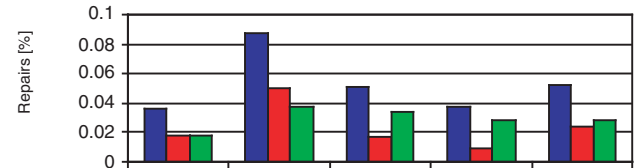

	2002	2003	2004	2005	Average
Received	0.036	0.087	0.051	0.037	0.052
Repair	0.018	0.05	0.017	0.009	0.024
Mishandling	0.018	0.037	0.034	0.028	0.028

Figure 2: Percentage of total repairs and mishandling (taken from Blain Hydraulics)

mishandling of the valve (dirt inside the valve, wrong adjustment, wrong assembling after servicing, etc.). These numbers were 0.037% and 0.028% in 2005, respectively. Having such a small percentage of failures for the key element of the hydraulic system statistically suggests that the hydraulic elevator systems have standards of reliability which are unequalled by traction systems.

As competitors, MRL manufacturers have been trying to reduce the popularity of hydraulic elevators by introducing two arguments as drawbacks of hydraulic elevators. These are energy consumption and environmental concerns. These arguments are mainly brought by traction-elevator manufacturers, while there are practically no complaints from end users. Understandably, such general statements and critical remarks against hydraulic elevators are aimed to increase the market share of MRLs by any means.

The Elevator Market

Large numbers of elevator installations have taken place in developed countries. The majority of such countries have considerable numbers of low-rise buildings, apart from those which have limited land space and large populations. In such countries, the hydraulic industry has also advanced, with high quality hydraulic elevator control valves, pumps, motors, jacks and other related equipment available at low prices. In addition, the outstanding advantages of hydraulic elevators also persuaded elevator companies and constructers to choose hydraulic drive units for their applications. There was also a public awareness of comfort and safety, which made the hydraulic type more favorable. As a result, hydraulic elevator installations were over 60% higher than the number of traction elevators installed worldwide (Figure 1). This trend changed around 1995, as traction MRLs were introduced into the low-rise market.

The advantage of having no machine room is much appreciated by civil engineers and architects, and the number of MRL installations has increased in a short time. The reputation of highly regarded multinational companies is another reason for general acceptance of traction MRLs. Reports reveal that the share of hydraulic elevators has reduced to 40% worldwide, and in 2010, two thirds of new elevators are expected to be MRLs. The statistical results for Europe in 2000 and 2004 are shown in Figure 3, where the rough data for Greece has been updated.[3] According to the statistics of 2000, 81% of elevator installations in the U.S. were of the hydraulic type.[4]

However, the situation of the hydraulic market is not as serious as it would seem. This is shown by the requirement for hydraulic control valves for elevator installations increasing each year. As an example, Blain Hydraulics produced 72% more valves in 2004 than 2000 (Figure 4). There may be more traction installations than hydraulic ones in coming years, but this doesn't prevent the yearly increase in hydraulic installations. With time, as the advantages of hydraulic elevators are acknowledged in developing countries, the ratio of hydraulic to traction installations can be expected to stabilize.

Surprisingly, in an industry that has prided itself on its safety record, with the introduction of the MRL elevator, in this author's opinion, major companies have sacrificed the safest elevator constructions in order to gain economic control of low-rise elevator installations. To favor this behavior, safety codes are being changed to relax the requirement for a seperate and secure machine room. Most people are not aware of the risks that may result from some of the code changes. Hopefully, the unnecessary risk being taken will be recognized before there are serious consequences.

Aiming to improve competitiveness, hydraulic elevator manufacturers have also developed MRL solutions intended to remove the necessity of the machine room,[5,6] allowing the power unit to be located inside the shaft, in the pit or within a landing-door assembly. When MRL applications are com-

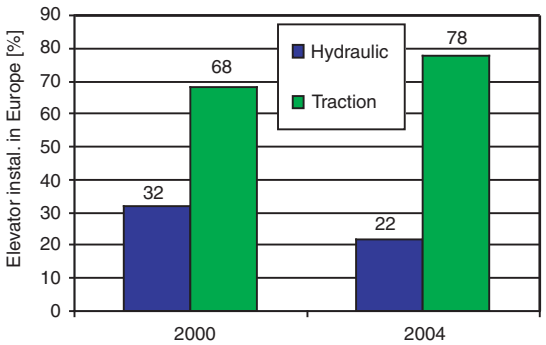

Figure 3: Percentage of elevator installations in Europe[3]

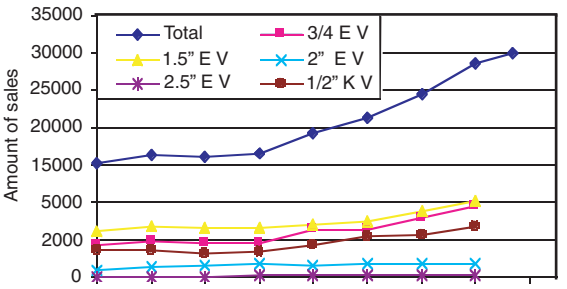

Figure 4: Increasing trend in control-valve production (taken from Blain Hydraulics)

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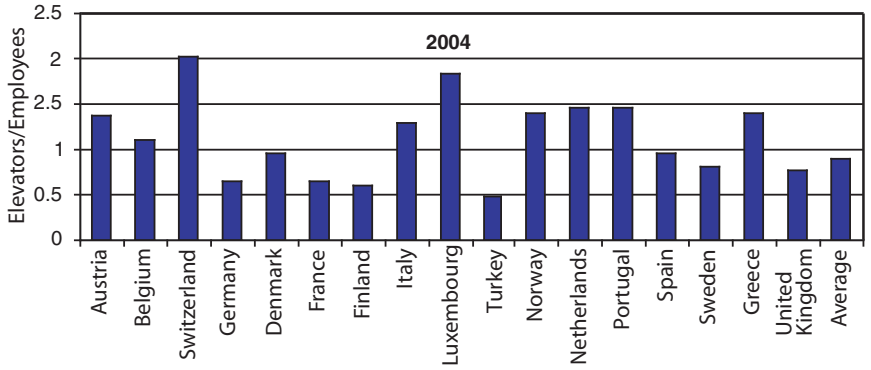

Figure 5: Ratios of elevator installations to number of employees in Europe[3]

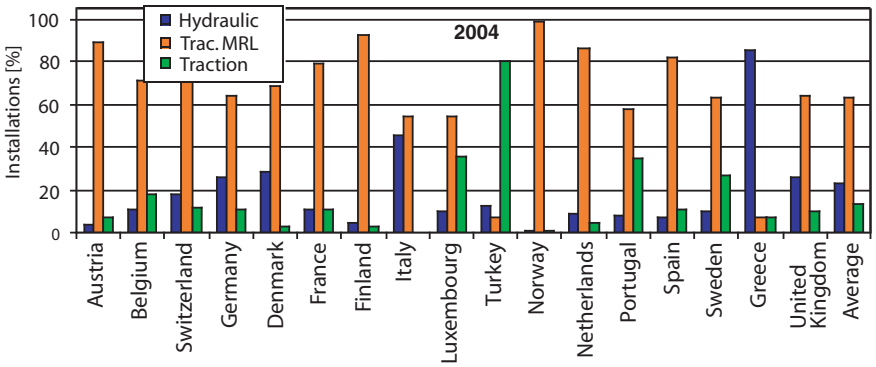

Figure 6: Percentage of elevator installations in Europe for 2004[3]

pared with regard to safety, hydraulic MRLs are better suited to applications that omit machine rooms than are traction MRLs. This is because, with hydraulic systems, all operations are carried out directly in the pit or at the lowest landing entrance for both the ease and the safety of the installer. In contrast, electric installations require maintenance on the cabin roof of the elevator, with machines placed in the potentially less safe upper part of the hoistway.

The Situation in Europe and Turkey

Figure 5 shows "Existing Lifts/Employees" ratios for various countries in Europe for the year 2004. In Turkey, the ratio is half of the European average. This can be interpreted as the competition in the Turkish market being more challenging in terms of the number of competitors. The next figure gives the percentage of elevator installations in Europe in the same year. From there, it can be seen that the European market is dominated by traction MRLs (except for the markets of Turkey and Greece). The highest number of elevator installations in Greece is the hydraulic type (approximately 85%), whereas the traction type with machine room dominates (80.4%) in Turkey. The hydraulic and MRL elevators are 12.9% and 6.7%, respectively, in Turkey.

The building stock of European countries is generally mid and low rise. As multinational companies have become stronger in the market, particularly with patented MRL systems, small and middle-sized companies have lowered their prices to stay competitive. This resulted in price cutting in the market followed by the multinationals' strategy of taking over small and middle-sized companies. Presently, the multinationals offer very competitive prices for new installations, on the basis of obtaining service contracts and selling spare parts. Maintenance can often be seen as the hen laying golden eggs. As a result of marketing strategy, 75% of the elevator business in Germany is shared between a few multinational companies, and the remaining 25% is shared by approximately 400 small companies, which are mostly in the servicing sector. If this trend grows, there will be no room in the market for small competing companies, which normally serve to keep prices reasonable.

In Figure 7, valve sales for various countries are indicated in percentages. From there, the current situation in Germany can also be clearly seen. Valve demand in Germany is decreasing due to the expansion of MRL applications. However, other countries show, in general, stable trends. Most valve sales are made to Greece and the U.S.

The situation in Turkey, which may have similarities with other developing countries in the Middle East and Far East, is at the moment challenging enough to prevent the multinationals from grasping the elevator market easily. In developing countries like Turkey, the use of elevators is increasing as the building quality advances. There is a large number of elevator and component manufacturers as well as servicing firms, the majority of which deal with traction elevators with machine rooms. Many such companies are small with only a few employees, and have a limited financial and technological

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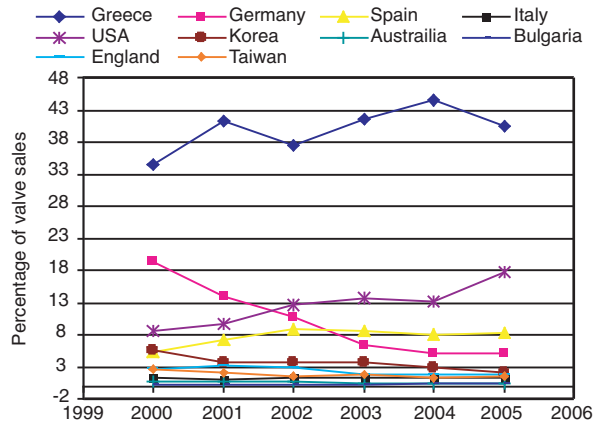

Figure 7: Percentage of control-valve sales to various countries

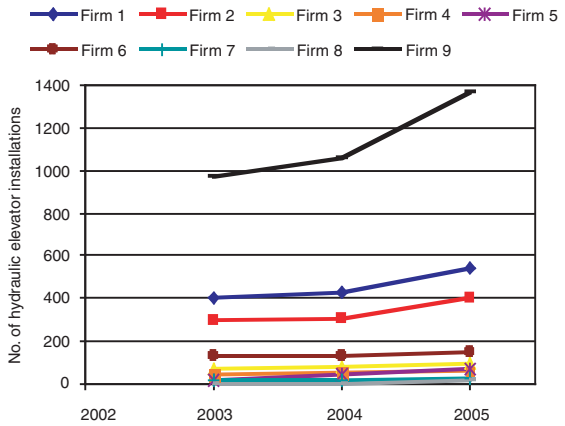

Figure 8: The number of hydraulic elevator installations in Turkey (taken from Blain Hydraulics)

foundation. The low prices of these elevator systems or equipment attract building constructors and owners. There are rumors that some firms are being awarded International Organization of Standardization and Conformité Européenné certificates is appropriately a matter of concern. Existence of undeserved certificates affects the competition in the market, creating huge price differences between the low- and high-quality products. On the other hand, since the customers are usually unaware of the most suitable elevator system for their needs, the price of the elevator system becomes a crucial factor in making their choice.

The hydraulic elevator is generally an unknown factor in Turkey, and therefore too few constructers recommend hydraulic elevators. Lack of competent hydraulic engineers and technicians in the elevator industry has great consequences on hydraulic elevator installations and servicing. It is easier to construct inferior elevators without considering better alternatives. Such behavior comes from a lack of knowledge and comprehension of the advantages of hydraulic elevators, which often have a better price/performance ratio than traction elevators. The popularity of hydraulic elevators in Turkey is nevertheless increasing steadily. Figure 8 shows annual sales records of seven major hydraulic elevator manufacturers in Turkey, which indicates a 29.3% increase in hydraulic elevator installations in 2005 with respect to the previous year.

The multinational companies are expanding in the Turkish market with MRL solutions. Their prices are still high for the Turkish market in comparison to those of hydraulic and traction elevators. At present, under such conditions, multinationals are not competitive with the MRLs.

Unsafe solutions should not be allowed in vertical-transportation systems. MRL manufacturers accept the fact that placing the machine in the shaft (either in the pit or in the headroom) is a conditional safety solution.[8] The most dramatic situation occurs in seismic regions. Hanging the machine in the shaft must also guarantee that it can withstand seismic movement. (In a previous paper, a comprehensive study on the suitability of different elevator types in the seismic regions was presented).[9] For instance, 93% of Turkey is in the active seismic zone, and 98% of the whole population is under earthquake risk. According to the statistics (State Institute of Statistics in Turkey, www.die.gov.tr), 97% of the total number of buildings in Turkey have six floors or fewer. The total number of new buildings (sorted by the number of floors through years) according to the occupancy permit is shown in Figure 9. It can be seen that the number of buildings has decreased through the years, and that the amount of high-rise buildings (six stories or taller) are having a lower ratio each year. However, in recent years, the increase in tall-building construction in seismic regions is another conflict against safety.

The consequences of earthquakes on traction lifts are far more dangerous than their consequences on hydraulic elevators. Assisting trapped people to escape is more difficult for ordinary citizens to accomplish in the case of MRLs.

It is a major responsibility of elevator-code makers and all elevator-related authorities to promote safer elevator systems. Future catastrophes will have greater or lesser consequences, depending on their decisions.

Conclusions

Although the percentage share of hydraulic elevators in the market has declined approximately 20-25% worldwide due to the emergence of MRLs, hydraulic elevators are increasingly being installed due to their unbeatable properties such as longer breakdown-free operation, low initial cost, easy installation, high comfort, etc.

The European market is dominated by MRL systems. On the other hand, the low-rise elevator market in developing countries is difficult to deal with. In these markets, traction elevators with machine rooms are leading. Hydraulic elevators are generally unknown there, and constructors suffer from lack of technical personnel. It is expected that MRL and hydraulic-elevator market shares will reach a constant ratio as the industry becomes familiar with hydraulic elevators.

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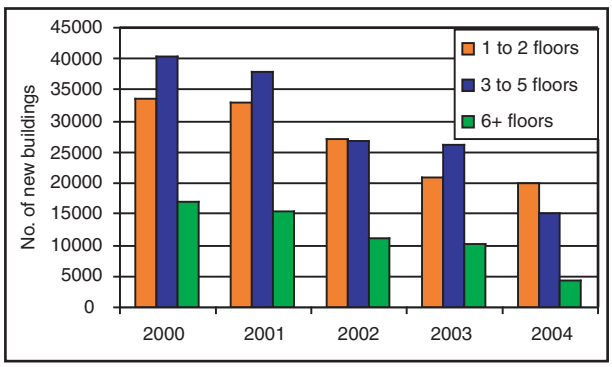

Figure 9: Total number of new buildings and number of floors, according to occupancy permits

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The first selection criteria for an elevator might be safety. Service-free operation time and the cost of servicing may follow. Hydraulic elevators clearly have the best records in these criteria.

An increase in safe hydraulic elevator installations produced by Turkish companies would help to improve the hydraulic industry in many ways, create new jobs and serve to advance the country in a better way.

The new traction MRL solutions are mostly intended to grasp the low-rise market. Countries with frequent occurrences of natural disasters should reconsider the acceptance of MRLs straight away. In these cases, the codes should be addressed to sustain a clear understanding of specific safety requirements.

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