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Advice paper

Making the case for facility revamping

How to initiate, prepare and manage facility redevelopment projects

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1. Introduction

Industrial companies are sometimes hesitate about whether to reuse and revamp existing infrastructure or build a new facility instead. Reuse could be indicated by various factors, including post-crisis caution, land scarcity, burgeoning environmental regulation, and investment cost considerations. But the case for revamping is rarely straightforward. Revamping existing structures is generally subject to more practical constraints than a newbuild, and the risks are often perceived to be higher. Revamping also brings significant technical challenges and always leads to compromise.

In this paper we outline the benefits and drawbacks of revamping an existing structure—generally of steel construction—and discuss a number of attention points and best practices. Advice is given on how best to initiate, prepare and manage such facility redevelopment projects.

2. A difficult trade-off

At first glance, the idea of reusing existing industrial infrastructure would seem relatively straightforward, since this is what industrial companies do all the time. Indeed, sites are continually being adapted to meet the changing needs of the business, whether it's to increase capacity or for a production line and process make-over. However, the case for reuse becomes less compelling when we are faced with older industrial buildings such as steel structures of the 1980s or 1970s, or even earlier. These structures may display severe wear or significant structural defects, casting doubt on whether they could be reused effectively.

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But what about newbuild? In general, the cost of developing new infrastructure is easier to assess, especially when building at a different location. Yet the administrative burden could be much higher and the impact of relocating production must be considered too. The choice of renovating or building new infrastructure will therefore always involve a difficult trade-off.

3. Facing uncertainties

Revamping always comes with a set of uncertainties for plant operators. Let's take a closer look:

- **Unknown structural quality**—Very often, the plant operator knows little about the quality of the existing structure. Is it essentially structurally sound, even as it displays severe signs of wear? Are the foundations still strong enough and will they be able to carry possible extra weight for many years to come? These are difficult questions, especially where original drawings and technical documentation are not available. In addition, the structure may have been adapted over time to meet changing needs, leading to further questions about whether the structure is adequate.

Renovation projects are more frequently subject to unexpected events and practical burdens.

- **Limited design flexibility**—An existing structure may offer limited design possibilities and be relatively difficult to adapt to the new function. Plant operators may fear that the resulting spatial organization will be suboptimal, affecting success factors such as functional and operational flows, maintainability of the buildings, and even the attractiveness of the site.

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- **Impact on production**—Production continuity must be assured when renovating structures at an operational site. But plant operators find it difficult to assess the potential impact of a planned renovation project in this respect.

- **Construction risks**—Renovation projects are generally perceived to be more complicated than newbuilds and are more frequently subject to unexpected events and practical burdens.

These uncertainties tend to complicate the trade-off between renovation and newbuild and may lead to missed opportunities.

4. Embarking with confidence on a renovation project

What can plant operators do to make way for fearless, confident decisions to renovate? How can they reduce the risks associated with a renovation project? And how can they keep costs and practical burdens as low as possible? There are three essential aspects to be considered:

1. The preliminary analysis should go into sufficient detail to allow a reliable assessment of costs and risks.

2. During the tendering process, bidder companies should be invited to consider design alternatives which allow them to globally optimize their proposed solution in terms of feasibility and costs.

3. The contractor should be explicitly requested to provide sufficient detail about how the complex interrelation of the different construction activities and plant operations will be managed.

Let's take a closer look at these aspects.

4.1 Auditing the premises

Most functionally-outdated industrial buildings offer significant possibilities to accommodate new functionality. They often are also in much better shape technically than at first might appear to be the case, even when there are obvious signs of degradation. This applies especially to steel structures. However, it requires comprehensive expertise to assess a structure's actual quality and potential. Inadequate preliminary analysis leads to missed opportunities for reuse. It is therefore recommended that a specialized company be hired to carry out in-depth inspection and analysis prior to deciding whether to renovate.

Such an inspection is sometimes called a 'technical audit'. It involves a team of experts who investigate the technical condition of every element of a building. This could be a visual inspection but could also involve carrying out appropriate measurement campaigns where called for. In bigger projects, the audit could involve developing a digital model of the existing structure, which could be used to evaluate the structure's stability and identify the critical structural components.

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The audit report includes the following:

- A list of defects observed in building elements such as columns, beams, floors, walls, roof coverings, doors, gates and windows. The list covers factors such as corrosion, small and large cracks, quality issues with respect to welding or bolting, conservation issues, and indications of fatigue.

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- Comprehensive advice on the long-term reliability and potential of the various elements and of the entire structure. This may also include advice on adapting the structure to new functions, for example whether additional platforms might be built.

It is important that the analysis goes into sufficient detail to allow the cost of a renovation as well as the related project risks to be assessed.

4.2 Triggering tenderers to globally optimize their solutions

There is a tendency among some project developers to compartmentalize construction projects, calling for separate tenders for the design, engineering, detailed study, manufacturing and construction stages. While this method increases competition—encouraging keen pricing—it fails to reduce the overall cost, especially in renovation projects. A design team with little or no engineering or manufacturing expertise is unlikely to identify opportunities for reuse. Similarly, an engineering office with little field expertise may overlook opportunities to enhance feasibility or simplify onsite activities to reduce costs.

Calling for a turnkey service will encourage tenderers to globally optimize their solutions, not just keeping costs as low as possible at each individual stage.

Non-compartmentalized tendering, calling for a turnkey service, is much better in this respect. It will encourage tenderers to globally optimize their solutions, not just keeping costs as low as possible at each individual stage. It will also attract those construction companies with a comprehensive service, from design through to build. Such companies are more inclined to call upon valuable field expertise at all stages of the project, leading to significant overall cost savings. This clearly enhances the case for redevelopment.

4.3 Planning and managing production continuity

When renovating at an operational site, it is essential that construction work has only limited impact on production. It is therefore of paramount importance that the contractors in a renovation project provide sufficient detail of how construction activities will be managed. Their project planning should include the following:

- Detailed scenarios for construction activities, including defining safety perimeters, temporary storage areas, and available time slots for all the activities involved.
- A risk analysis listing the potential points of interference between construction activities and plant operations. This includes risks related to delays in materials deliveries or subcontractor services.
- A clear commitment that during work, a direct line of communication is maintained with the operations manager to allow unexpected circumstances to be addressed rapidly and safely.

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5. Examples of industrial renovation projects

No two renovation projects are alike. Each project presents different challenges and carries different risks. Let's look at some real-world examples.

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5.1 Renovating a chemical process tower

The 10m by 10m steel tower housing a crucial process installation at a chemical plant was due for renovation. The structure was 50 years old and showed severe signs of wear, mostly as a result of year-round exposure to aggressive substances. A budget was secured for a thorough renovation, but there were no detailed drawings of the original structure, and additional equipment and elements that had been tacked on to the structure over time could possibly be compromising its strength and long-term viability.

A comprehensive measurement campaign was therefore carried out to clearly identify any weak spots before a cost-effective proposal for renovation, indicating the parts needing repair or replacement. The project also had to be carried out without shutting down the process. Consequently, scenarios and procedures were developed to dismantle and assemble parts without disturbing the process. This involved temporarily attaching and securing cables and ducts while taking measures to comply with the stringent site safety standards. Before this, tests were carried out on one level of the tower to help finetune scenarios and procedures where necessary.

5.2 Design weakness identified and corrected

A severe problem was detected in a transportable exhaust hood at a stainless steel melting shop. The hood, which rests on a trolley running over two rail beams, is positioned above the casting ladle to allow 1500°C hot exhausts produced during the heating process to be expelled. The trolley wheels showed signs of wear, and on further inspection the rail beams were slightly bowed. This was alarming, since it was an issue that the supplier had insisted was addressed a year earlier when some small cracks in the rail beams were repaired. Apparently, this hadn't prevented the phenomenon from happening again. It became clear that it would not suffice to simply replace the beams.

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A project was launched to find the root cause of the problem. The entire exhaust hood, of which no up-to-date drawings were available, was carefully measured to determine its weight. In addition, the exhaust hood and beam designs were analyzed against the operational conditions of the installation, particularly the high temperatures.

The analysis revealed that the entire structure weighed no less than 60 tonnes, in part due to elements that for various reasons had been added over the years. In addition, the beams, composed of welded flange plates, proved to be ill-suited to withstand the temperature fluctuations.

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Eventually, the 240 kg/m welded beams were replaced by 360 kg/m rolled beams, with the addition of heat radiation protective shields. Two damaged columns were also renovated, and new crane wheels of greater strength and better heat resistance were installed.

5.3 A touch of inventiveness to reduce risks

A building needed to be extended by about 40 metres to accommodate an updated stainless steel production process. However, production downtime had to be reduced to a minimum, meaning that there was only a two-week timeframe available during the Christmas break to connect the existing building with the new structure. Initially, the idea was to remove the existing roof to allow a hydraulic mobile crane to be used for the connection work. But this would risk substantial delays in the event of unfavourable weather conditions.

By installing an additional overhead crane in the connection zone, the roof could remain undisturbed and the weather would not impact the exercise.

An unconventional alternative solution was used instead, involving the installation of an additional overhead crane in the connection zone. This meant that the roof could remain undisturbed and that the weather would not impact the exercise.

5.4 Analysis reveals burnt-out storage depot can be renovated

A storage depot at a waste processing company caught fire, severely damaging the roof and inflicting smoke damage throughout.

At first, the company thought of pulling down the entire building and constructing a new one.

However, a technical audit was carried out to assess the structure's integrity which revealed that the steel structure had not suffered and, to save time and money, it would be better to renovate the building.

5.5 Extending a sugar beet-washing line

A sugar producer's beet-washing line needed to be extended to allow a 25% capacity increase. The washing line is the beating heart of the factory during the 'campaign season', when the sugar beets are harvested. Incoming beets are carefully washed in several stages using a fast and highly-automated process which must be carried out with great precision to ensure that not the tiniest bit of dirt remains.

It was decided to optimize the use of space by building additional structures within and around the existing building, making for some tough technical and organizational challenges:

- The existing structure was carefully measured to allow the design to be optimized, and to prepare for the complex engineering work, taking into account the structural vibrations induced by the washing equipment.
- The measurement campaign was carried out in the middle of the harvesting campaign, making good communication with the operations manager essential.
- Connecting the older building with the new extension imposed very tight tolerances on the manufacturing process.
- Detailed construction scenarios helped workers to successfully deal with the limited manoeuvring space.

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6. Conclusion

The renovation or extension of existing industrial facilities presents a succession of specific challenges, mostly related to structure quality, limited design flexibility and the potential impact of a project on plant operations. A comprehensive preliminary analysis is recommended before embarking on any such project. It is also of crucial importance to get contractors to globally optimize their solutions, from design to execution. Careful planning is essential and a touch of inventiveness can make a huge difference, especially when production has to continue during construction work.

i. While this paper primarily focuses on revamping steel structures, it also touches on the more general subject of brownfield versus greenfield development.

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