THE CONCEPT OF INTEGRATION IN INDUSTRIAL DEVELOPMENT

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SYNOPSIS

Industrial Development is the synthesis of contributions from four major factors, namely, Business, Technology, Government and Labour and successful industrial projects can be achieved only through a close co-operation and mutual understanding between these contributors.

The concept of integration in industrial development is based on the creation of integrated organizational structures, including all main contributors acting as a team, their objective being the successful completion of the project.

This paper analyses various levels of integration, from industrialization schemes to individual industrial developments and further to integrated technology.

For all those involved in industrial development, it would be beneficial to have a general view of conditions and major contributing factors, in order to understand and apply the concept of integration for the benefit of their projects.
1.0 INTRODUCTION

Industry is one of the fields of human activity where through processing of raw materials more valuable goods are manufactured with the purpose of satisfying society’s material needs and creating wealth.

In our paper we will refer only to the classical industry which creates material goods through organized manufacturing processes, generally in large quantities, opposed to the today’s common usage of the term “industry” for activities of large proportions aimed to generate money through services such as: tourism, banking, insurance or entertainment, “industries”.

Industrialization or the action of developing industry on a large scale, generally at national level has a great importance for the economic growth of the country with its positive results in creating general wealth and employment together with the offspin social improvement effects.

Where new industries are created in undeveloped areas, new settlements are built to accommodate industrial personnel and entrepreneurs are attracted by opportunities to serve the new industries and their relatively high income people. The positive effect of industrial development may expand even further as it may encourage development of general infrastructure of the area such as transportation, water and power supply, which in turn may attract development of other sectors of economy. We can see that in addition of being a provider of growth and employment on its own interest, industrialization generally has catalytic effects on many other socio-economic aspects of a Region or of the whole Country. Maputo industrial corridor is a clear example of an infrastructural development created along a cluster of industries, which in time is expected to attract additional industrial and urban development.

2.0 HISTORICAL BACKGROUND

In order to understand the new concepts in industrialization, it would be beneficial to briefly review the historical background of the industrial development and regard it as an evolutionary process.

The roots of what is in our days called “modern industry” may be traced to the 18th Century England with the Industrial Revolution when several important inventions and introduction of machinery followed by the “factory system” resulted in significant increase in trade and profits together with socio-economic changes.

As industrialization spread over Europe, North America and Japan, creating what is known as the “Developed World”, technological advances encouraged by the increased demand of the market and by the two World Wars, contributed to the modernization of the industry in the form presently known.
A second Industrial Revolution started in the second half of the 20th Century and continued until now when space, nuclear, electronic, telecommunication and other new industrial technologies are progressing at an accelerated pace. Presently, four fields of research are the frontrunners of technology, namely: I.T., Bio-engineering, New Materials and Renewable Energies.

Intensified industrialization created the problem of environmental pollution which in the past was no matter of concern, but now became a major issue to be taken into account, before any new industrial development is to be considered.

Industrial development is part of the market economy and although its evolution was controlled by the law of supply and demand, its progress was heavily influenced by other factors as well, such the many wars which occurred in the last two centuries which promoted advancements in military technology.

History teaches us that when industrialization was driven by political forces, rather than market ones, as it happened in the Eastern European former communist block, the results were catastrophic, leading to the total collapse of their economies and eventually of the whole political system.

This draws the conclusion that if industrialization is carried out unrealistically, it becomes a negative socio-economic factor, for which, the industrialization concept should not be blamed, but only the wrong policies.

3.0 INDUSTRIALIZATION

Creation of industry on a large scale or industrialization of a country or region is a process which requires certain conditions to be met in order to make this process sustainable for at least a period commensurate with the amount of capital invested.

The main conditions required to attract investment are:

- Resources

This is the main condition, as industry is based on processing raw materials or manufacturing of goods. Resources may be of various kinds and need to be in an adequate quantity.

Natural: minerals, forestry, agricultural, natural sources of energy, water etc.

Artificial: electric energy, infrastructure.

Human: quality labour, culture.
• Political/Economical Stability

This is an important condition for any viable, long term industrialization.

However, there are cases of “pirate industrialization”, where short term, risky enterprises are developed in unstable political/economical areas where rich resources are available and exploited in a primitive way for a quick profit. Examples of this kind of “industrialization” are found in countries like the Congo and Angola where illegal mining is carried out in insecure conditions. However, for a stable, long term industrial development, political stability, including stable and peaceful industrial relations, together with monetary stability and investment and trade encouraging policies are considered as basic conditions.

• Market Conditions

Market demand for a produce should be carefully considered in terms of price, supply and fluctuations of both on short and long term.

Having complied with all the above conditions, industrialization may become an attractive opportunity for capital investment in a certain country or region on the assumption that the intended commodities can be produced at a competitive price, adequate quality and reliable supply.

INTEGRATION at Regional level with the aim of promoting industrialization in the region, should include :

• Rationalizing or sharing infrastructure (harbours, roads, rail etc.), and water resources.
• Trade agreements regarding taxation, customs etc.
• Monetary accords.
• Work accords allowing free labour migration.

INTEGRATION at National level should include :

• Agreements between state departments for participation in the creation of industrial infrastructure.
• Incentive fiscal legislation.
• Agreements on development priorities considering the local and national interests.
• Privatization or public/private partnership policies.
4.0 INDUSTRIAL DEVELOPMENTS

Within the industrialization process taking place at Regional or National scale, individual industrial developments can be created by benefiting from the basic conditions already in existence and by particular opportunities.

Generally speaking, four major factors are contributing to industrial development and their contributions and motivations are the following:

<table>
<thead>
<tr>
<th>Contributor</th>
<th>Contribution</th>
<th>Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investor</td>
<td>Capital</td>
<td>Profit</td>
</tr>
<tr>
<td>Developer</td>
<td>Technology</td>
<td>Profit and reputation</td>
</tr>
<tr>
<td>Local Population</td>
<td>Labour</td>
<td>Employment, welfare</td>
</tr>
<tr>
<td>Government</td>
<td>Infrastructure, Natural resources Legislation</td>
<td>Taxation</td>
</tr>
</tbody>
</table>

This is a rather simplistic description of the industrial development scenario, because contributors may play more than one role and they may have additional contributions and motivations, for example, the investor may be at the same time his own developer or government may become also an investor. With privatization, government may be involved in partnership with private investors, or simply may sell land or infrastructural assets to them. The developer may also become a partner in investment by taking some equities in the development.

Industrial developments may be classified in three categories:

- Grass roots - When the development is taking place from an undeveloped site.
- Brown field - Expanding an existing industrial site.
- Red field - Re-vamping production facilities under operational conditions.

Each of these categories has its own specific character concerning the financial, managerial, technical and labour matters, therefore, needs to be treated in a different manner.

In the case of grass root projects, there are two distinct phases to consider:

**Phase 1 - Development (Fig. 1a)**

The four main contributing factors and their roles are:

- **Business** - Capital and management
- **Technology** - Process - Industrial Development Engineering
- **Labour** - Construction personnel - Operational staff in training
• Government - Infrastructure
  - Environmental regulations
  - Economic policies

**Phase 2 - Production (Fig. 1b)**

The same four main contributing factors play different roles in this phase:

- **Business** - Plant management
  - Marketing

- **Technology** - Industrial Engineering
  - Research and Development

- **Labour** - Operational Personnel
  - Maintenance Staff

- **Government** - Taxation
  - Infrastructure Maintenance
  - Environmental Control

![CONTRIBUTING FACTORS TO INDUSTRIAL DEVELOPMENT](image)

Figure 1

In the case of Brown and Red Fields, these two phases are not that distinct and the roles of the four main contributing factors may be somehow different from those played in the Grass Roots case.
It becomes quite clear that due to the important roles each of these four main factors play, in the process of industrial development, co-operation and accommodation of each other’s requirements are essential for the success of the project.

INTEGRATION at industrial development level means that all four major factors operate as an integrated team, aiming to create a plant to produce at designed output capacity and quality, within the planned investment cost and construction schedule. Within this integrated frame-work, initiative and innovation could be encouraged, and thus performance expectations could be exceeded.

5.0 THE BUSINESS – TECHNOLOGY RELATIONSHIP

It was proved that, where Business and Technology engaged in an industrial project, co-operate and continuously consult with each other, the resulting effect is increased profits, together with further business and technological opportunities, which would satisfy the aims of both parties.

There are numerous examples of successful co-operation, particularly in the new industries such as IT, Telecommunications, Automation, etc., which are creating an economic and technological boom in their fields equivalent to an Industrial Revolution.

At the same time, traditional industries, particularly heavy industry, slipped in the opposite direction where Business took control in its hands regarding the decisions for new developments by considering that profits may be generated mostly by good management and marketing and by using bought-out, conventional technology.

The reason for such a situation is that Business, through its Project Management component, shows on many occasions little technical knowledge and even less confidence in the advice it may receive from its Technological partner, therefore it goes for what seems to be technically safe and proven even if outdated.

Sometimes this point of view may be justified by the fact that some technical consultants themselves advocate for conventional technology to be used for various reasons such as time pressure, commodity to analyze the risks associated with promoting new technologies, or simply lack of knowledge in new technologies.

The results of such a philosophy are:

- stagnation of technological progress
- lowering the impact of Technology in decision making which affects in particular its Engineering component.
There is only one way to rectify this situation and this is to prove to Business that employment of advanced technology does pay, giving thus Business the competitive edge, and to the contrary outdated technology would create greater losses in due time.

If this message is understood, automatically the position of Technology relative to Business would be amended for mutual benefit.

6.0 TECHNOLOGY

Technology for industrial development is not a monolithic body but a combined multitude of engineering disciplines. At the core of each industrial project stands the Process which is specific for each, industrial sector and plant and this on its own is based on one or multiple engineering disciplines. Once the Process was established, it needs to be physically carried out by a plant or an industrial complex designed and constructed by engineering disciplines operating together as a body called Industrial Development Engineering (IDE). By definition IDE is the multi-disciplinary field of engineering activity specialist in the development of industry, incorporating Civil, Mechanical, Electrical and Control Systems industrial engineering disciplines. It should be clarified that the industrial development engineering disciplines are vastly different from other applicable fields of their own discipline.

For instance, the industrial development mechanical discipline is different from say automotive mechanical engineering or industrial civil engineering different from civil engineering for property development albeit the basic principles on which they operate are the same.

It should be noted that IDE is neither Project Management nor Industrial Engineering although it is closely involved with both.

The aim of IDE should be to engineer industrial developments in the most efficient way regarding quality, cost and duration of construction of the facilities which shall perform according to the process requirements.

There are various ways in which IDE is being operated within industrial development projects.

The most efficient way is when all engineering disciplines involved are interactive among themselves and with the Process they serve, (Fig 2) thorough total technological integration.
Through this interactivity at all phases of the development including the conceptual phase, best technical and economical solutions can be found and applied, with a superior industrial complex resulting.

The project also benefits from the fact that permanent contact between disciplines reduces substantially the time to produce and transfer design information from one discipline to another with the effect of reducing the total duration of the project.

In the case of turn-key contracts, when the contractor is also part of the engineering group, consultations between designer and contractor at conceptual phase would result in improved constructability which in turn would reduce the duration of construction and costs.

However, there are still many projects where partial disciplinary interactivity is applied, some disciplines (civil in particular) being excluded from the conceptual phase of the development (Fig. 3) with obvious negative effects.
How Industrial Complexes are actually engineered?

After the Process is selected and Process Flow Diagrams (PFD) established, the Mechanical discipline follows with Mechanical Flow Diagrams (MFD) and Piping and Instrumentation Diagrams (P&ID) from which a Plant Layout (Plot Plan) showing the physical location in space of various items of equipment is produced.

Starting from the issuing of the PFDs all disciplines, including Civils, should be involved in the design if the engineering is going to be fully interactive.

This is the conceptual phase where through interaction the whole design may be optimized. From here, during the detail design phase, thousands and thousands of discipline interfaces need to be solved and coordinated, this being mainly a Project Management function.

The point to make is that without participation of all disciplines at conceptual phase, the benefits of applying advanced technology will not be achievable.

On the other hand, participation in detail design only, leads to conventional solutions, inefficient plant layouts, preventing also the application of radically advanced concepts as the design information flow is unidirectional. (See Fig. 3).

The reasons for this situation commonly given are either that new technology may be too risky or it is too late and there is no time to experiment.

It shows that multidisciplinary integration does not come automatically and there is need to be promoted together with the promotion of advanced technology.

INTEGRATION at Technology level means full disciplinary interactivity during all stages of the project.
7.0 CONCLUSION

Integration of major contributing factors is the key of success in developing modern industry under the climate of increasingly tough local and international competition.

In order to attract investment, integration at Regional and National level is required to create political, economical and infra-structural favourable conditions for industrialization.

At individual industrial development level integration is required to bring the project to successful completion.

At Technology level total multi-disciplinary integration is required to create most competitive plants through innovative concepts.

Integration allows each contributor to industrial development to orientate himself in the larger scenario of the environment in which the project is created, to know other contributor’s needs and expectations and operate accordingly.

For project managers, integration should be of great assistance as many barriers between contributors to development could be cancelled and through partnership or co-operation the project can be completed in a more direct manner with benefits in costs, time and performance. However, organizing an integrated project requires a larger amount of preparation and knowledge but in the end, all this extra effort will substantially pay back to all the contributors to the project.

8.0 REFERENCES


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Lyonell Fliss was born and educated in Romania.

He graduated in Civil Engineering at the Technical University of Civil Engineering of Bucharest where he also received a MSc. degree in Industrial Civil Engineering.

He immigrated to South African in 1975 joining Roberts Construction and at present is a Chief Civil Engineer of Engineering Management Services of the Murray and Roberts Group.

During his career he has been involved in the design and construction of major industrial projects in Europe and Southern Africa.

He has published several papers related to various aspects of civil design and construction of industrial developments.

At his initiative the first Symposium on Industrial Civil Engineering was held in June 1996 in Johannesburg, which was followed by the creation of the multi disciplinary Industrial Development Engineering Association (IDEA) of which he has been the Chairman since 1998.