
The Birth and Progress of Brazilian Die/Mould Clusters: The Joinville Mechanism

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Abstract:

This study analyses the birth and progress of Brazilian die/mould clusters. There were three large die/mould industrial clusters in Brazil located in the Southern area s; viz, the ABCD district (Santo Andre, Sao Bernardo do Campo, Sao Caetano do, and Diadema) of Sao Paulo, Joinville of Santa Catarina, and Caxias do Sul of Rio Grande do Sul. The largest die/mould industrial cluster with Brazilian ownership is in Joinville, many owners and employees of which are Brazilians. We focuses on Joinville, how and when its die/mould cluster born and developed by a case-study-approach.

As conclusion, we divided sixth stage to explain our research question. The first stage of the development of the Joinville die/mould clusters spanned across the 1930s and 1970s. At this time, die/mould users needed to import all dies/moulds from foreign countries as there were no die/mould manufacturers in Brazil. The second stage was in the 1930s-70s when die/mould users gradually started to manufacture dies/moulds in their in-house tool divisions. The third stage emerged between the 1970s and 1980s when certain enterprises spun out these tool divisions and started their own die/mould companies. The fourth stage was during the 1970s-80s. Die/mould manufacturers emerged in the third stage and operated die/mould maintenance services and/or manufactured die/mould parts to meet the demand. The fifth stage was seen during the 1970s-80s when the die/mould manufacturers acquired accurate die/mould technologies through a learning-by-doing approach and began to produce dies/moulds themselves. The sixth stage was found to be between the 1990s-2000s. As the die/mould demand grew, some entrepreneurs spun out and started their own die/mould companies and progressed from stages 4 to 5. In this way, the Joinville die/mould cluster was born and progressed. Thus, we named this the “Joinville Mechanism”.

Keywords: Brazil, die/mould cluster, Global Value Chain, CASE,

1. Introduction and research question

This study analyses the birth and progress of Brazilian die/mould clusters. It focuses on Joinville, one of the top three die/mould clusters in Brazil.

Die/moulds are special metal tool-attached production machines such as machines used for metal stamping, injection moulding, metal die-cast, glass or rubber moulding, metal powder moulding, forging, and casting. The die/mould is used to produce parts with the same shape in large quantities quickly. Currently, the 3D printer is in the limelight in production of a variety of goods and parts, and can also produce parts with the same shape. However, die/moulds are used in mass production owing to its advantages over a 3D printer, such as production cost or process speed.

The automobile and electronics industries are representative of the die/mould user industries. Several thousand auto parts are required to produce one automobile. Several sets of dies/moulds are needed to produce one auto part. Thus, multitudes of dies/moulds are needed to produce one automobile. These dies/moulds are used in industries using materials such as plastic, metal, glass, rubber, among others. As the size of parts varies from a few millimetres to over a few metres, the sizes of the dies/moulds also vary accordingly. The quality requirements for a die/mould are the precision of shape, surface roughness, durability, and ease of maintenance. In the R&D of new automobiles, the die/mould significantly impacts the realisation of the designer's idea. Occasionally, designers offer complex shapes that are lightweight and durable to match recent trends, such as eco-friendliness, connected, autonomous, shared services, and electric (CASE), at reasonable prices. The quality of dies/moulds plays a critical role in realizing designers' dream.

Brazil has become one of the top ten car manufacturing countries worldwide. In many car manufacturing countries, it is difficult to procure domestic dies/moulds. Several new automobile production countries have identified the importance of die/mould and have attempted to grow their die/mould industry. However, they have also identified that it is very difficult to produce good quality dies/moulds that match the automobile manufacture's stringent quality, cost, and delivery (QCD) requirements. Brazil has three large die/mould clusters, among several others; viz, the ABCD district (Santo Andre, Sao Bernardo do Campo, Sao Caetano do, and Diadema) of Sao Paulo, Joinville of Santa Catarina, and Caxias do Sul of Rio Grande do Sul.

This study focusses on how the Brazilian die/mould clusters have birthed and progressed. For this, we conducted a field survey in Joinville.

2. Three large die/mould industrial cluster in Brazil

According to a field survey from 2012 to 2019 by the author, there were three large die/mould industrial clusters in Brazil located in the Southern area, as shown in Fig. 1.

Figure 1. Die/mould Industrial Clusters in Brazil



Author

In the Sao Paulo state, there are approximately one thousand operational die/mould manufacturers. The main area is the ABCD district with 400 operational die/mould manufacturers, majority of which are mould manufacturers for plastic injection machines. The others are die manufacturers for metal stamping machines or mould manufacturers for metal moulding or metal die-cast production. The owners of these manufacturers are multinational, including Brazilians, Italians, Germans, and Japanese.

The largest die/mould industrial cluster with Brazilian ownership is in Santa Catarina state, where 450 die/mould manufacturers are in operation. Among them, 300 die/mould manufacturers were in Joinville, many owners and employees of which are Brazilians. A large number of these are German-Brazilian. Manufacturers of moulds for plastics are the most popular. There are also die manufacturers for metal stamping and mould manufacturing for metal casting.

The other die/mould industrial cluster with Brazilian ownership is in Caxias do Sul in the Rio Grande do Sul, the southernmost state in Brazil. In Rio Grande do Sul, 380

die/mould manufacturers are in operation, with 300 in Caxias do Sul. Many owners and employees of these manufacturers are Italian-Brazilian. Several manufacturers among these make moulds for plastic injection, and some make dies for metal stamping and moulds for metal casting.

In addition to the three industrial clusters, there are other die/mould manufacturers in Brazil, such as in the Curitiba or Resende. However, these three districts are remarkable from the perspective of manufacturing scale as a die/mould industrial cluster. Although many manufacturers use die/mould in Manaus of the Amazonas state, many procure their die/moulds either from the three main clusters or import them. Occasionally, they make a die/mould in-house for themselves.

3. The Birth and Development of Joinville Die/Mould Industrial Cluster

Joinville was founded in 1871 with immigrants from Germany, Switzerland, or Northern Europe¹. Three million immigrants arrived here from 1851 until the 1900s. The population of Joinville was 58 million in 2018², many of whom are German-Brazilian. Joinville is a city of commerce and industry. We observed that many houses and buildings were built with the German style of architecture (Figure 2). When we visited the factories in this area, we were overwhelmed by their superiority that was not generally seen in Brazil. Occasionally, factories were built with the German style of architecture with red bricks. Many European machine tools were used in factories, such as machining centres, die-sinking electric discharge machines, and wire electric discharge machines. Several of their employees are German-Brazilian (Figure 3).

Figure 2. Joinville city (by author in 2017)



¹ Joinville city : <https://www.joinville.sc.gov.br/>

² Joinville Cidade em Dados 2019 – Ambiente Construído : <https://www.joinville.sc.gov.br/wp-content/uploads/2019/08/Joinville-Cidade-em-Dados-2019-Ambiente-Constru%C3%ADdo.pdf>

Figure 3. Die/mould factory in Joinville (by author in 2017)



3.1. Overview of Joinville die/mould industrial cluster

The characteristics of Joinville’s business style are similar to those of the Japanese die/mould industry. First, many of them manufacture die/moulds full-time and sell it to outside customers. Second, many of these manufacturers are small and medium-sized companies. Third, they experience pride in making high-quality dies/moulds.

Employee and technological information of the die/mould manufacturers in this cluster is shown in Table 1. Thirty companies hired over 30 workers each, and 100 companies hired 20–30 workers each. There were 220 companies with under 20 employees each. There are six companies with global top-level technologies, and 22 companies classified as having medium-high-level technologies. Hundred and twenty companies were classified as having medium-low technologies, and 200 companies with low-level technologies.

Table 1. Overview of Joinville die/mould industrial cluster

Employees	(Companies)	Technologies	(Companies)
Over 30	30	Global Top	6
20~30	100	Medium-high	22
Under 20	220	Medium-low	120
		Low	200

According to an interview with Mr Dehilman

3.2. Core enterprises to generate Joinville die/mould industrial cluster

According to the interview survey conducted, four companies were deeply concerned about the emergence of Joinville die/mould industrial clusters. These are Tigre³, Embraco⁴, Tupy,⁵ and Multibras⁶.

Joao Hansen Jr., a twenty-five-year-old entrepreneur, founded Tigre. He bought over a comb factory named Tigre⁷. At that time, 23 workers made combs by processing animal horns. After World War II, he saw many imported plastic products in the domestic market and decided to produce plastic products by himself. He bought plastic injection machines from Europe in 1952–53 and produced plastic products such as accessories, daily necessities, and toys, for which moulds were imported from Europe. He aggressively visited plastic exhibitions in Europe and decided to produce a pipe with polyvinyl chloride (PVC). The PVC pipe became Tigre's core product. Tigre is an important PVC pipe manufacturer in Brazil, currently producing various plastic products or industrial tools.

Embraco manufactures compressors used in refrigerators. In the 1970s, companies did not manufacture compressors for refrigerators; electronic manufacturers needed to import them. Embraco was founded in 1971 as a compressor manufacturer. Around the time of the company's establishment, they made in-house tool shops. As there were no companies making dies/moulds, they had to either import or manufacture it themselves. They learned and enhanced die-making technologies, and Embraco was the first company to introduce a CNC (Computer Numerical Control) machining centre in Brazil in the 1980s. Many popular die/mould making machines were introduced in their tool shop using globally advanced technologies, which the Japanese die/mould manufacturers wanted to introduce between the 1970s to the 1980s in Japan. In the 1990s, Embraco produced dies for developing motor cores by introducing technologies from Europe. In the 2000s, they enhanced their die-making technologies by leveraging computer technologies. In the 2010s, Whirlpool⁸ bought over Embraco and in 2019, a Japanese company bought over it from Whirlpool, making it a subsidiary.

Tupy was founded in 1938 by Albano Schmidt, Hermann Metz, and Arno Schwarz⁹. Schmidt focused on a kind of iron-casting joint pipe, being imported from foreign countries. They faced several challenges in making the iron-casting joint pipes.

³ TIGRE, <https://www.tigre.com.br/>

⁴ EMBRACO, <https://www.embraco.com/ja/>

⁵ TUPY, https://www.tupy.com.br/ingles/empresa/estrutura_jlle.php

⁶ Doing Business in Santa Catarina, <http://en.reingex.com/Brazil-Santa-Catarina-Business-Economy.shtml>

⁷ TIGRE, <https://www.tigre.com.br/memoria-tigre/en/products-story>

⁸ Whirlpool, <https://whirlpoolcorp.com/>

⁹ TUPY, <https://www.tupy.com.br/ingles/empresa/historia.php>

After a trial and error for ten years, they finally succeeded in making it. He then founded Tupy and produced the iron-casting joint pipe. This joint pipe was accepted widely in the Brazilian market under the brand name “Tupy”. Schmidt passed away in 1958, and his son, Hans Dieter Schmidt, inherited Tupy. He focused on the automobile industry as a new business core, and in 1958, they received their first order for parts for brakes from WW. He established the Tupy Technical High School in 1959 for human resource development, adapted to automobile technologies. In 1975, they succeeded in creating engine blocks and engine heads. Their iron-casting automobile parts were accepted in the automobile industry. Today their main products are for the automobile industry.

Multibras were white electronics product-making manufacturers, founded in 1994 by merging several companies¹⁰. The companies merged to form Multibras cannot be identified today. We call them Pre-Multibras companies (PM) for convenience in this study. Multibras were the top electronics manufacturers in South America in the 1990s and the 2000s. In the 2000s, Whirlpool took over Multibras and made them their subsidiary. Many mould manufacturers say that they sold their moulds to Multibras first and then continued to sell to Whirlpool.

3.3. Establishment stories of some companies in Joinville die/mould industrial cluster

(1) Herten

The founder of Herten was a German-Brazilian. The grandparents of the founder emigrated to Joinville from Germany in the mid-19th century. They were engaged in farming in Germany and continued it in Brazil. German was their spoken language, and the founder learned Portuguese, which is the official language in Brazil. The founder was unintentionally born bilingual in German and Portuguese.

The founder disliked engaging in farming and, therefore, engaged in industries. He worked in a factory from when he was 17 years of age. He worked for the Tigre tool shop from 1966 to 1976. Before they made a die/mould in Joinville, all dies/moulds were imported from foreign countries, such as Germany, Switzerland, and Austria. Tigre was also in the same situation. He accumulated skills and technologies related to moulds in this tool shop. His bilingual ability was very useful in learning this skill. He visited a die/mould exhibition in Europe where conversations regarding die/mould with professionals were often conducted in German.

In due course, the management at Tigre decided to outsource mould manufacturing. He then resigned from Tigre and founded Akros in 1977 with five

¹⁰ Doing Business in Santa Catarina, <http://en.reingex.com/Brazil-Santa-Catarina-Business-Economy.shtml>

members. One of the founding members of Akros was a relative of the founder of Tigre. They sourced mould maintenance and manufacturing jobs from Tigre. He then resigned from Akros and founded Herten in 1981 with ten people. They started to make moulds for Tigre and Akros. Then, they started to source mould manufacturing jobs, corresponding to the demand in Joinville. They were the first company to make moulds for aluminium die-casting in Joinville. Gradually, there were requirements for dies/moulds from Germany and Argentina, and they started to export.

When starting their die/mould business, there were no schools that covered die/mould technology in Brazil. Thus, it was taught as on the job training (OJT). They aggressively recruited graduates from SENAI (National Service for Industrial Training of Brazil) as graduates from SENAI had basic industrial skills and knowledge.

At the time of the interview in 2019, their sales ratio was 60% from moulds for Al die-casting and 40% from moulds for plastics, such as for moulding chloroethylene. Twenty sets of moulds were made annually for Al die-casting and 50 for plastics.

(2) Mold Tool¹¹

The founder of Mold Tool was Spanish-Brazilian. The father of the founder was then engaged in farming. His sons wanted to live in cities and engage in industries. The founder learned the skills and knowledge related to metal processing in SENAI. After graduation, he worked for several companies, such as Hansen Maquinas. In those days, die/mould users made their die/mould in-house in their tool shop because there were very few die/mould manufactures outside Brazil. Die/mould users decided to outsource their die/mould needs as they were inefficient, and the process tended to have a high production cost to make small quantities of dies/moulds for their use. At Hansen Maquinas, they were mainly engaged in the maintenance and production of moulds for Tigre. There were only a few die/mould manufacturers in Joinville in the 1990s, only six of which could be recalled by the interviewees. It is not small member who belonged to Hansen Maquinas in the die/mould owner here today, they said. The role of Hansen Maquinas was very significant to grow human resources for die/mould industry here.

The founder started his own die/mould business with co-workers from Hansen Maquinas in 1995. They collected funds by selling their cars and with the support of family and friends to start their business. They bought a lathe in Curitiba and started their businesses. At first, they contracted a job for mould-maintenance or making parts for moulds, and gained skills and technologies related to dies/moulds through their business. In 2000, they founded Mold Tool with 34 people, focusing on making the moulds and

¹¹ In this paper, we use term “Mould” under British spelling. Here as it is company name, we use spell of “Mold”.

started their business with offers mainly from Tigre. Gradually, offers from the automobile industry increased. They enhanced their knowledge and technologies, through activities such as by coaching the ex-owner of die/mould manufacturing in Sao Paulo. Today, most of their moulds are used in the automobile industry. As of 2019, Mold Tool had 92 employees. They made 85 sets of moulds in 2018, of which 90% were for automobiles and 10% for motorcycles.

(3) JN

JN was founded in 1987. The founder was an Italian-Brazilian. The grandparents of the founder migrated to Brazil from Italy in 1885. They were engaged in farming in Italy and continued to do so in Brazil. The founder was engaged in farming until the age of 14. However, he was interested in industrial activities. He joined SENAI and acquired machining skills and knowledge related to the manufacturing industry.

After graduating from SENAI, he worked as a lathe operator at Tupy and became a foreman after a few years. He also worked at Embraco. When he realised that he had sufficient skills, he decided to start his factory. He procured a lathe and milling machine and started his workshop with one of his brothers. In those days, he conducted machining process of a variety of parts. These parts included dies/moulds parts such as for moulds for die-casting, moulds for plastics, and dies for stumping. He then gained knowledge regarding dies/moulds by processing their parts.

In 1995, he made a mould by himself. The first mould he made was used for die-casting. He then started a mould manufacturing for die-casting business despite the presence of his competitors in Joinville. In those days, there were many mould manufactures for plastics and die manufacturers for metal stumping. There were only a few mould manufacturers for die casting.

As the founder was fluent in Italian, he gathered information and knowledge regarding mould manufacturing in Italy. He aggressively visited die/mould exhibitions and factories in Italy.

As of 2019, 110 employees worked at JN. In 2018, they created 250 sets of moulds, most of which were manufactured for the automobile industry.

(4) 3R

3R was established by three founders in 2005. The name 3R represented the first letters of the names of the founders' spouses. One of the founders had worked for Embraco, and wanted to start his own business after accumulating enough skills and knowledge of technologies. The other founders were his colleagues and childhood friend from his home

state of Parana. They started their business with one milling machine in their workshop. They received orders from Embraco to process metal parts. Gradually, they accumulated skills and knowledge on dies/moulds, and developed a mould in-house in 2013. They gradually shifted their business from processing parts to manufacturing moulds. In the early 2010s, majority of their customers were in the electronics industry. Gradually, they catered their moulds to suit the automobile industry.

As of 2019, there were 25 employees at 3R, half of whom were graduates from SENAI. In 2018, they manufactured 60 sets of moulds.

(5) Winter

Winter was established in 1999. The founder's father was an immigrant from Germany. While he was engaged in farming, the founder wanted to engage in industrial activities. He entered the mould manufacturing industry at the age of 14. He had accumulated skills and knowledge of technologies and became a leader in the tool shop in Multibras when he was 35 years of age. In 1999, he established a company with five people who started making moulds from scratch owing to the founder's skill and knowledge. In early stages, they manufactured moulds that were relatively easy to make, such as those with a simple structure, without accuracy of dimension, or with simple work material-characteristics. Gradually, as they gained experience, they manufactured more complex moulds.

As of 2019, there were 50 employees at Winter. In 2018, they manufactured 50 sets of moulds, 90% of which were for the automobile industry, and 10% for the electronics industry. Moulds are used to produce bumpers, grills, and door panels in the automobile industry.

(6) Top Line

The Top Line was established in 2003, with three people. The founder joined SENAI in 1984 and gained metal processing skills and knowledge. He graduated from SENAI in 1987 and started his own business. He was engaged in metal processing activities using a lathe, milling machine, and CNC machining centre. The founder conducted metal processing of die/mould parts or maintenance of die/moulds for manufacturers such as Mold Tool. He decided to manufacture the die/mould, based on his experience in with mould parts processing and mould maintenance, to increase profit. They finally started to manufacture dies in 2007, the first of which was a progressive die of connectors. Later, they shifted to making moulds for plastics from dies used for metal stamping to increase their profit. Currently, their main products include moulds for

plastics.

As of 2019, the company had 35 employees. In 2018, they manufactured 56 sets of moulds, 13 of which were for Tigre, and the remaining for the automobile industry. Many of the employees were from SENAI and Tupy Technical High School.

4. Conclusion: The Joinville Mechanism

4.1. Consideration from Case-Studies

This study, employed a case-study-approach to analyse how the Joinville die/mould industrial cluster was born and developed.

Joinville is a colonial town established in 1851. Many immigrants came here, mainly from Germany, Switzerland and northern Europe. They were farmers in their native countries and continued their agricultural activities in Brazil. Gradually, some of their descendants became interested in working in the industrial sector. Some of these people started manufacturing and using dies/moulds. In the early stages, the dies/moulds were imported. They set up the tool division for die/mould maintenance. Based on their experiences using the dies/moulds daily, they gained knowledge on die/mould technologies. In the beginning, they took on maintenance activities and then graduated to manufacturing parts for the die/mould, and finally made the die/mould in their in-house tool division. However, the cost of doing this was considered unreasonable. The investment required for the machines used for manufacturing dies/moulds was considerable. The small number of their own dies/moulds were considered insufficient to make profits. Die/mould users outsourced maintenance and procured dies/moulds from outside. Thus, a demand for the dies/moulds and their maintenance was born in Joinville.

However, the in-house tool division played a part in developing skills and knowledge of dies/moulds. While some die/mould users preferred to have their own company. Certain users pushed themselves to establish die/mould companies because they relied on external die/mould suppliers. In some cases, entrepreneurs gathered funds to procure machines and establish their own workshops. Thus, the early germination of the Joinville die/mould industrial cluster was born between the 1970s and the 1980s.

In the 1980s, because the demand for dies/moulds was not so large, only a few companies were enough to fulfil the requirement. Based on the interviews conducted, the 1980s saw ten die/mould manufacturers in Joinville, as shown in Table 2.

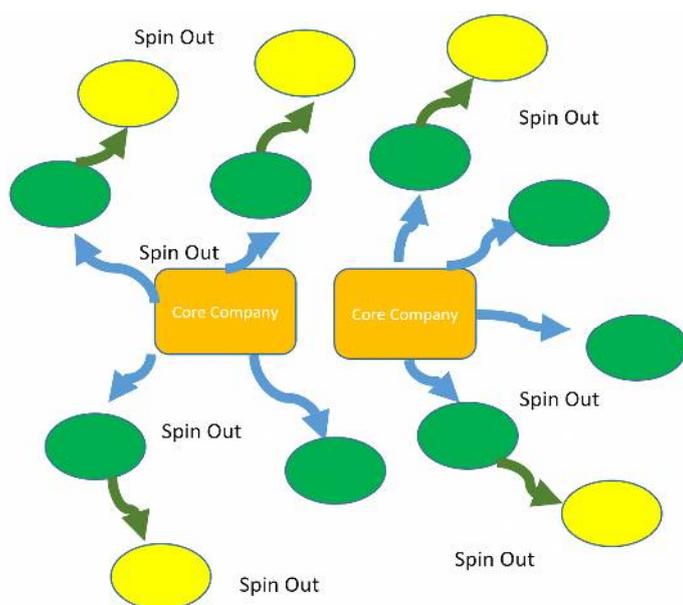
With the economic boom in the mid-1990s and after the 2000s, demand for dies/moulds increased. As the number of die/mould manufacturers increased in Joinville, dies/moulds customers from outside Joinville, such as from Sao Paulo, came to Joinville to fulfil their requirements. Then, the demand for dies/moulds increased further.

In the early stages of every enterprise established, the core companies played the role of an incubator to nurture die/mould professionals. Similarly, the die/mould manufactures of the first-generation also acted as incubators. The second-generation and later-generation companies are as shown in Figure 4.

Table 2. Die/Mould Manufactures in an Earlier Stage in Joinville in 1980s

Company name	Purpose of their dies/moulds	Employees	Main Customer
Hansen Maquinas	Plastics	300	Tigre
Sul Moldes	Unknown	55	Embarco
Garibaldi	Plastics	80	PMs
Cato	Plastics	35	Tigre
Manchester	Metal Stamping and Plastics	70	Tupy
Schiodini	Die-casting and Metal Stamping	40	Tupy
Herten	Plastics and Die-casting	45	Tigre
Akros	Plastics	-	Tigre

Figure 4. Development Mechanism of Joinville Die/Mould Industrial Cluster (Joinville Mechanism)



Author

4.2. What happened, how and when

The first stage of the development of the Joinville die/mould clusters spanned across the 1930s and 1970s. At this time, die/mould users needed to import all dies/moulds from foreign countries as there were no die/mould manufacturers in Brazil. The second stage was in the 1930s-70s when die/mould users gradually started to manufacture dies/moulds in their in-house tool divisions. The third stage emerged between the 1970s and 1980s when certain enterprises spun out these tool divisions and started their own die/mould companies. The fourth stage was during the 1970s-80s. Die/mould manufacturers emerged in the third stage and operated die/mould maintenance services and/or manufactured die/mould parts to meet the demand. The fifth stage was seen during the 1970s-80s when the die/mould manufacturers acquired accurate die/mould technologies through a learning-by-doing approach and began to produce dies/moulds themselves. The sixth stage was found to be between the 1990s-2000s. As the die/mould demand grew, some entrepreneurs spun out and started their own die/mould companies and progressed from stages 4 to 5. In this way, the Joinville die/mould cluster was born and progressed. Thus, we named this the “Joinville Mechanism”.

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