

AN INTERPRETATION OF EVOLUTION AND PHASES OF PROÁLCOOL IN VIEW OF SELF-ORGANIZATION THEORY

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ABSTRACT: his paper analyses the PROALCOOL evolution (from 1975 to 2000) in view of Self-Organization Theory. For this purpose, the pros and cons will be analysed and compared with particular reference to the criterion of decision. This criterion modify in agreement with the PROALCOOL evolution and its important events, after interactions between PROALCOOL's elements. As a result of paper, a "bottle neck" in the productive process originated by the oil crisis gave rise to an environment favouring energy alternatives. The sugar cane industry crisis generated an "interest arrangement" that lead Brazil to opt for the PROALCOOL Program. In the second phase (1980-1985) the disturbance and interactions was accented. The "bottle neck" worsened from 1980 to 1985 due to the second oil crisis, generating a favourable environment for producing hydrated alcohol. From 1986 to 1995, PROALCOOL went from a slower growth to a crisis (deceleration and crisis). The "bottle neck" generated by the oil crisis disappeared, and so did the justification to maintain corporativism around the program. The phase of crisis and rearrangement (1996-2000) is presenting signs of backup of PROALCOOL. But, in this phase the ambient where the system interacts is not very favourable to PROALCOOL. Now, for the Program it is important to grant attention to costs, to the development of new technology and to take advantage of the by-products.

KEY WORDS: PROALCOOL, Self-Organization Theory, evolution.

UMA INTERPRETAÇÃO DA EVOLUÇÃO DO PROÁLCOOL COM BASE NA TEORIA DA AUTO-ORGANIZAÇÃO

RESUMO: Este trabalho analisa a evolução do PROÁLCOOL (de 1975 a 2000) à guisa da Teoria da Auto-Organização. Com este propósito, são expostos os

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“prós” e “contras” desse Programa comparando-os com referência ao particular critério de decisão a que esta Teoria alude. Este critério foi modificando-se de acordo com a evolução do PROÁLCOOL e de seus eventos importantes, mediante interações entre os próprios elementos caracterizadores do PROÁLCOOL. Como corolário, a crise do petróleo gerou um “gargalo” no processo produtivo, propiciando um ambiente favorável ao surgimento de alternativas energéticas. A crise da agroindústria canavieira favoreceu a “orquestração” de interesses e levou o Brasil a optar pelo PROÁLCOOL. Na segunda fase (1980-1985), evidenciou-se o aprofundamento do “gargalo”, provocado pela segunda crise do petróleo, propiciando um ambiente favorável para o lançamento do álcool hidratado. De 1986 a 1995, passou-se de um período de desaceleração do crescimento à crise do PROÁLCOOL. O “gargalo”, oriundo da crise do petróleo, desapareceu. A fase de crise e rearranjo (1996-2000) apresentou sinais de recuperação do PROÁLCOOL. Mesmo assim, nessa fase, o ambiente em que o sistema interagiu não foi, de todo, favorável ao PROÁLCOOL. Atualmente, para o Programa é importante centrar atenção na redução de custos, no desenvolvimento de tecnologia nova e é preciso avançar em um melhor aproveitamento dos subprodutos derivados da cana-de-açúcar.

PALAVRAS-CHAVE: PROÁLCOOL, Teoria da Auto-Organização, evolução.

1. Introduction

Sugar cane was most important for the Brazilian history. This crop was responsible for the successful beginning of the Brazilian colonisation process based on agricultural enterprises. The sugar cane's reputation was larger and characterised, between 1530 and 1650, the sugar cycle, a phase when sugar was the dominant product of the Brazilian economy (Furtado, 1974).

Szmrecsányi (1979) indicates that a wide variety of products are obtained from sugar cane, including sugar, one of the basic human foods. Other important products obtained from sugar cane are alcohol, molasses, yeast, pulp, etc. For the author above, the economic importance of sugar cane is directly related to the number and functions of its alternative uses. Currently, despite the relative progress achieved in terms of economic uses of sugar cane by-products such as pulp (used as fertiliser, cellulose production, fuel and animal feed) and “vinhoto” (used as fertiliser), the main products from the sugar cane industry continue to be sugar and alcohol.

Today the sugar-alcohol market puts into motion about R\$ 12.7 billion per year, which means 2,3% of the Brazilian GDP, generating a tax revenue of R\$ 1.2 billion and near 602.000 direct jobs. The national sugar cane market has got approximately 322 mills in activity, being 101 autonomous distilleries (producing alcohol only) and 221 sugar cane mills (producing sugar and/or alcohol). Furthermore, this agribusiness has got 60.000 sugar cane suppliers, 60

representative institutions and 4.000 firms that make products and services from the sugar cane market. The harvested area 97/98 produced 301 million tons of sugar cane, generating 15 million tons of sugar and 15.2 billion litres of alcohol (5.5 billion litres of anidro alcohol and 9.7 billion litres of hydrated alcohol). Brazil is a greater sugar cane producer and the only to implant in wide scales an alternative fuel to the gasoline. Today the alcohol is recognised worldwide for its externalities and social advantages, and countries from the 1st world already are interested in the Brazilian technology (Shikida, 1998; Anuário Jornalcana, 1999).

In fact, the performance of the sugar cane industry had been affected by the behaviour of sugar and alcohol markets. According to Ricci *et al.* (1994), the harvested area with sugar cane rose mainly due to a higher international sugar price during 1973-1975. It continued to grow by diversification policy, especially with the implementation of the Alcohol National Program (PROÁLCOOL, Brazilian siglum) in 1975 - for its execution there was a strong official support, such as advantages of financing, fiscal incentives, subsidies and price incentives.

However, between 1986 and 1999, the PROALCOOL impetus was diminished and the international sugar price showed some stability. Then started a crisis of PROALCOOL, being characterised by cooling of the State intervention in the Brazilian sugar cane industry (this, valley to say, in a “neoliberal” conjuncture of State and affected by a serious fiscal and financial crisis).

Nowadays the great problem for the PROALCOOL has been the low price of international petroleum. In this context where the alcohol cost still is higher than gasoline cost, PROALCOOL yet shows advantageous on pollution control, jobs generation, etc.

Some works have been made with relation to PROALCOOL using theories as the neocorporatist (Belik, 1992), neoschumpeterianism (Shikida, 1998), input-output matrix (Shikida & Guilhoto, 1996), etc. The PROALCOOL analyse, based on Self-Organization Theory, can contribute to understand this Program because its theoretical conceptions allow an explanation with original insight. The Self-Organization Theory - concerning Maturana - was developed to be able to describe complex systems that modify in relation to time and space.

This paper analyses the PROALCOOL evolution (from 1975 to 2000) in view of Self-Organization Theory. For this purpose, the pros and cons will be analysed and compared with particular reference to the criterion of decision. This criterion modifies in agreement with the PROALCOOL evolution and its important events, after interactions between PROALCOOL's elements. This paper is structured as follows: the next section shows the brief notes about the Self-Organization Theory. Afterwards, it discusses the phases of the PROALCOOL showing an evolution of the Program in view of Self-Organization Theory. The final considerations conclude this work.

2. Notes About the Self-Organization Theory¹

The Self-Organization Theory - concerning Maturana - was developed to be able to describe complex systems that modify in relation to time and space. This organization is defined according to the relationship between the components, describing how the parts of the system act ones with the others. Thus, the components and the real relations, fixing the “organization degree” that belongs to the unit determine the structures of organization. The denomination “organization degree” is attributed for two types of organization: the one that contains different elements in different amounts; and the other that possessed greater homogeneity between elements. In the first case, the “organization degree” is more raised.

The self-organised systems can interact with the ambient (open system), not to interact with the ambient (closed system) or, in part, is its proper ambient (autopoiesis system). In case of disturbances, can appear some interactions with the ambient or to be a consequence from an internal dynamics.

The self-organised system is distinguished for the fact of changes in a parameter, simultaneously modifies all the system and itself, being narrowly on with ideas as evolution and dynamics. Hence, the structure and organization define a composite unit where some units can interact with others. This panorama is dynamic, being determined for interaction of the components of the unit. The structural alterations result from disturbances in these systems and determine its development, also providing the history of its interactions. Through this disturbance, that is selected the routes so that the system can repel this disturbance.

In fact, the disturbance is an action that constitutes the evolution of the system, making possible the self-organization development. A system has permanently repelled the disturbance, at the same time that is the disturbances that also condition its operations and its changes of structures. The system is not a steady entity and definitively ready but a structure that is established in permanent process. If a disturbance takes to a structure change, meaning the loss of some structures, hardly all the structures and the proper organization are lost. However, in case of the interaction to become destructive to the organization as system form is lost.

In summary, Maturana describes the Self-Organization showing that the dominant process that organises the system is determined by disturbance that is situated between the systems and ambient.

The Self-Organization Theory has particular interest for the economy, because, for Krugman (1996):

¹ This section is based in Maturana & Varela (1980) and Flickinger & Neuser (1994).

Temporal self-organization in the economy is more familiarly known as business cycles, or yet more familiarly as booms and crashes (err, depressions; err, recessions; err, slumps; err, slow-downs). Since Keynes (at least) the idea that these are in some way self-reinforcing has been common, and Krugman resurrects a body of Keynesian theory from the '50s, "non-linear business cycle theory." This is of the order-from-instability type, and so predicts a characteristic size to business cycles, which, on a comparison of 1933 with the recent unpleasantness, or even the early 1980s, is less than plausible. Krugman also presents an order-from-random-growth theory - really percolation theory in wolf's clothing - which avoids that problem at the cost of " [making] less contact with what seems to happen during a boom or slump, " and predicting a power law distribution for business fluctuations, which is not observed. Charitably, Krugman chooses to "regard them both more as illustrations as how one might approach self-organization in time than as finished statements of how one actually ought to do it." Some such theory will be necessary if we are not to continue treating shifts in aggregate demand as external shocks - administered, perhaps, by the vengeful specter of Karl Marx (Krugman, 1996, p1)

3. Phases of PROALCOOL

3.1. MODERATE EXPANSION OF PROÁLCOOL (1975 TO 1979)

PROALCOOL was created in 1975 after a serious petroleum crisis (begun in 1973), in a period where the Brazilian economy developed, according to Castro & Souza (1985), in rhythm of "forced march". The international petroleum prices in September of 1973 were at US\$ 2.91 per barrel, and this crisis collaborated for its quadruplicating.²

Brazil, in that period, depended in 80% on petroleum from exterior. Consequently, the expenditure for petroleum import amounted to US\$ 8.6 billion regarding the triennia 1974-75-76. For comparing, in the previous triennia the expenditure for petroleum import was only US\$ 1.4 billion. With this imbalance, the Brazilian government and some managers manifested interest to finding energy alternatives. Programs were proposed with this purpose, such as: PROÓLEO (objectifying to substitute the oil diesel by vegetable oil), PROCARVÃO (to substitute the combustible oil by coal) and PROALCOOL (to substitute the gasoline by alcohol), being the last that had larger support and results.

First of all, two crises, of petroleum and the sugar cane industry (this due to instabilities of the external sugar market and excesses of investments

² More considerations about the PROÁLCOOL, to see: MENESES (1980).

previously made in the sugar cane industry), both in the middle 70's, contributed to make PROALCOOL to stand out. A "bottle neck" in the productive process originated by the petroleum crisis gave rise to an environment favouring energy alternatives. The sugar cane industry crisis generated an "interest arrangement" that led the country to opt for the PROALCOOL Program.

Some facts of PROALCOOL can be understood while applications and forms of the Self-Organization Theory. The first fact is the disturbance. The disturbance is an action that constitutes the evolution of the system, making possible the self-organization development. A system has permanently to repel the disturbance, at the same times that are the disturbances that also condition its operations and its changes of structures. Thus, in sugar cane industry the disturbance were initially the "bottle neck" originated by the petroleum crisis (interactions with the ambient) and the sugar cane industry crisis (consequence from an internal dynamics), that led the Brazil to opt for PROALCOOL Program while route so that the system can repel this disturbance.

This alternative based on combustible alcohol was well formulated politically serving both, private and public interests. This was not verified for another energy option because in the areas of those alternative programs, there were no crises like that in the sugar cane market, and there were no comparably strong pressure groups.

The "interest arrangement" around the PROALCOOL included: the managers of sugar cane mills and autonomous distilleries; the State; the section of machines and equipment; and the automobile industry. For the managers it was necessary to diversify their production. The interests of the State consisted of the following objectives: economy of exchange value; decrease of regional income inequalities; growth of income and job interns; and expansion of capital goods. For the section of machines and equipment, this program was important for sale of products to the sugar cane industry. Specifically for the automobile industry, the petroleum crisis was an obstacle to the Brazilian motorway political, and the car - moved by alcohol - showed as an alternative of continuity to this model (Belik, 1992).

Furthermore, for the PROALCOOL execution there was a strong official support, such as: advantages financing, fiscal incentives, subsidies and price incentives (Magalhães *et al.*, 1991). The basic instruments of the PROALCOOL implementation (in its first phase) consisted of an establishment of remunerating prices to alcohol, through the parity with sugar price; in warranties to purchase alcohol from Brazilian Petroleum S.A. (PETROBRÁS), and the creation of credit lines to agricultural and industrial parts financing.

With the beginning of PROALCOOL, the producers were subject to a series of government institutional arrangements that warranted a subventionist paradigm as a survival model. In this context there was a growth of production in the sector with very little importance given to technological progress. In

this regard, the first phase of PROALCOOL (1975-1979) can be considered as moderate expansion.

During the moderate expansion US\$ 1.019 billion were invested, in which case 75% was public money and 25% was private money. For this phase the goal of production was 3 billion litres of alcohol established for the harvest 1979/80. This goal was surpassed in 13,2%. This alcohol production was based on sugar cane mills yet operative and the production was focused on anidro alcohol (type of alcohol to additive with gasoline).

Other point about PROALCOOL is the environmental argument. For example, sugar cane cultures have got a high degree of photosynthesis capacity, and cars moved by alcohol have less emission of carbon monoxide, carbon dioxide and nitrogen oxide than cars moved by gasoline.³ Moreover, sugar cane is a renewable culture, with cycles of 4-5 years, and produces several by-products. In terms of job generation, for 1 job generated in the oil sector, 152 are generated in the sugar cane agribusiness (Carvalho, 1996).

However, still with a rising petroleum price (near of US\$ 12 per barrel), after the first petroleum crisis, the alcohol barrel cost yet remained well higher (near US\$ 60 per barrel) than the gasoline barrel cost. Then, although the PROALCOOL Program was entirely to position of the private sector its notable growth depended on wide government subsidies and a strong “interests arrangement”.

Other fact of PROALCOOL can be understood while applications and forms of the Self-Organization Theory. This fact is linked with an idea of relationship between the components. In PROALCOOL was evidenced that the alternative based on combustible alcohol was well formulated politically in level of private and public interests, included: the managers of sugar cane mills and autonomous distilleries; the State; the section of machines and equipment; and the automobile industry. In this case it is important to stand out that the denomination “organization degree” attributed for PROALCOOL is higher because contains different elements in different amounts. This panorama was dynamic and determined for interaction of the components of unit, each with its interests. Therefore, the PROALCOOL - initially based on the subventionist paradigm - was a manifestation found to repel one disturbance in sugar cane industry, but due to the initially interactions depended on its implementation on wide government subsidies and a strong “interests arrangement”.

³“Conventional private vehicles emit a number of products that may be considered potential health or environmental problems. (...) These pollutants may lead directly to: nuisance (odour, noise, soiling or decreased visibility); health effects (irritation of respiratory, eye, or other system; acute toxic effects; mutagenic or carcinogenic action; rise in blood pressure and other physiological effects); or environmental damage (materials soiling or corrosion; loss of agricultural productivity, etc.)” ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD, 1986, p.9).

3.2. Accelerated Expansion of PROALCOOL (1980 to 1985)

Another conflict - Iran against Iraq - contributed to the second phase of PROALCOOL (1980 to 1985), with petroleum prices reaching high levels of more of US\$ 30 per barrel. In the same period, there was also an increase of international interest rates. This accelerated the production and use of hydrated alcohol as fuel and gave more emphasis to the new construction of autonomous distilleries. This Program objectified to reach the alcohol production of 10.7 billion litres in 1985, that is to say, more than to triplicate the production in approximately six years, besides strengthening its initial purposes (economy of exchange value, job creation, etc).

The “bottle neck” worsened from 1980 to 1985 due to the second petroleum crisis, generating a favourable environment for producing hydrated alcohol. Simultaneously, the “interest arrangement” supported the hydrated alcohol as the most adequate energy option for the substitution of oil derivatives, surpassing programs such as vegetable oils and coal energy.

In the second phase important movements for an enlargement of PROALCOOL were verified. The sugar cane industry intensified the production of hydrated alcohol and also started an autonomous distilleries expansion. For the State, the PETROBRÁS remained responsible for alcohol commercialisation, giving producers a guarantee of purchase and sharing stock costs with them (Olalde, 1993). Incentive to use cars moved by alcohol were implemented, such as the reduction of aliquot of Tax on Industrialised Products (IPI) and Rate Only Motorway, and the establishment of a consumer price limit of hydrated alcohol at 65% (relation to the gasoline price). Furthermore, an obligatory addition of 22% of anidro alcohol in gasoline was defined. About the institutional panorama, new financial agents of PROALCOOL were included, as some private commercial banks, investment banks and economic boxes (Moreira, 1989). Furthermore, the financing conditions of investments sponsored by the State continued advantageous. For the industry of machines and equipment as well as the automobile industry, their productions were stimulated due to opportunities of expansion of their markets. Particularly the automobile industry intensified their research to improve the use of hydrated alcohol as only fuel between 1975 and 1979. Accordingly, cars moved by alcohol could be implemented in 1979 (Parro, 1996).

Given this new panorama, a larger quantity of resources should be invested. Approximately US\$ 5.5 billion were invested in the Program between 1980 and 1984, in which case 56% was public and 44% was private money (Lopes, 1996). Compared with the previous period (1975 to 1980) this value expressed a growth of 430,5%. Moreover, it verified also a decrease in the public share and an increase in the private.

Therefore, in view of Self-Organization Theory, in the second phase the disturbance and interactions was accentuated. The subventionist paradigm was confirmed as form, found for “interest arrangement” to repel this disturbance. Through this aggravation in the disturbance that was definitely selected the route - hydrated alcohol - so that the system can repel this disturbance.

However, simultaneous to this PROALCOOL enlargement, new technological developments occurred that opened dynamic perspectives to the sugar cane industry. Macedo (1996), for example, puts the occurrence of larger efficiency in sucrose conversion for the final product. The payment of sugar cane harvested had a substantial innovation, stopping the method by ton of cane (quantitative aspect) and starting the method by sucrose quantity and purity of the broth (qualitative aspect).

In fact, the gains in terms of agricultural revenue for the sugar cane industry surpassed 60 tons per hectare (starting from 1982). Between 1977 and 1985, the agricultural revenue increased for 19,5%, while the industrial revenue (litres per ton of sugar-cane) increased for 23,2%. This meant an annual increment in the productivity of the sugar cane industry of 2,25% and 2,64%, respectively, for the agricultural and industrial segments (Magalhães *et al.*, 1991).

The hydrated alcohol and anidro alcohol production was, respectively, 8.621 million and 3.200 million litres (harvest 1985/86). Moreover, the production of cars moved by alcohol corresponded to 96% in 1985. These data show that this second phase of PROALCOOL had an accelerated expansion.

Although PROALCOOL had favourable arguments due to high petroleum prices, with a limited technological competitiveness of alcohol engines compared to gasoline engines and still high production costs of alcohol, the economic viability of the Program was at risk, despite technological advances. There is no doubt that the central idea of the “interest arrangement” was to make PROALCOOL an important Program for the Brazilian energy matrix.

Then, during the second phase of PROALCOOL, the “interest arrangement” was still more intense than in the first phase, because it gathered interests from industry and agriculture sectors as well as those of the final consumer (Belik, 1992). According to Ricci *et al.* (1994), the PROALCOOL involved multiple interests where each one knew what they wanted. For Melo & Pelin (1984), with occurrence of the second petroleum crisis the government authorities made, in an atmosphere of a worsened external crisis, fundamental decisions without the large economic background, considering other parameters than economic ones.

In this relation of the elements of the system itself, and with the system and ambient had a high harmony (“interests arrangement”) for the PROALCOOL to take off. According to the Self-Organization Theory, this is to entwine of autonomous parts of the system with different degrees of order.

3.3. Decelerated and Crisis of PROALCOOL (1986 to 1995)

From 1986 to 1995, PROALCOOL went from a slower growth to a crisis. The “bottle neck” generated by the petroleum crisis disappeared, and so did the justification to maintain corporativism around the Program. Then, the disturbance like the first and second phase of PROALCOOL disappeared too (the self-organised system is distinguished for the fact of changes in a parameter simultaneously modifies all the system and itself). But, the PROALCOOL already is a system that, in part, is its proper ambient. Hence, in this Program the structure and organization pass for others interactions that define a new composite unit. Necessary now is PROALCOOL survival without the disturbance from petroleum and sugar cane crises. In others words, the current disturbance accurately is given by an indefinite PROALCOOL while energy program.

Between 1985 and 1990, US\$ 0.511 billion were invested in the Program, in which case 39% was public money and 61% was private (Lopes, 1996). This value was the smallest invested in PROALCOOL meaning, respectively, 50,1% and 9,5% of quantities applied in the first and second phases.

Besides the gradual retreat of the public investments participation, advancing a decrease of State intervention in the sugar cane industry (Eid, 1996) started an alcohol-provisioning crisis from the harvest 1986/87. As can be verified through the table 1, the imbalance between production and consumption of Brazilian alcohol was not a fortuitous phenomenon.

In reality, this imbalance between supply and demand of combustible alcohol implied the import of product starting from 1989 (Parro, 1996). However, one of PROALCOOL objectives was an economy of exchange value, and these imports contradict this proposition.

TABLE 1 - Production and consumption anidro and hydrated alcohols, Brazil - 1985/86-1995 (million of litres)

Harvest or Year	Production			Consumption		
	Anidro	Hydrated	Total	Anidro	Hydrated	Total
1985/86	3.200,0	8.621,0	11.821,0	2.212,6	6.761,7	8.974,3
1986/87	2.163,1	8.352,9	10.516,0	2.426,1	8.760,3	11.186,3
1987/88	1.983,7	9.470,2	11.453,9	2.012,0	8.983,1	10.995,1
1988/89	1.725,9	9.987,3	11.713,3	1.973,6	10.128,3	12.101,9
1989/90	1.451,7	10.429,2	11.880,9	1.332,5	10.614,8	11.947,3
1990/91	1.288,5	10.494,0	11.782,6	1.872,5	9.899,8	11.772,3
1991/92	1.986,8	10.765,3	12.752,1	1.756,2	10.031,2	11.787,4
1992	1.986,8	10.729,4	12.716,2	1.899,0	9.630,7	11.529,7
1993	2.216,4	9.480,6	11.697,0	2.548,3	9.404,4	11.925,7
1994	2.522,6	8.763,0	11.285,6	2.850,4	9.665,1	12.515,5
1995	2.869,1	9.837,7	12.706,8	3.367,8	9.722,0	13.098,8

Source: extracted of Shikida & Bacha (1999)

Another indicator of PROALCOOL reduction can be verified through the variation of the harvested area with sugar cane. For moderate expansion the geometric rate of growth of harvested area was equivalent to 6,6% per year. For accelerated expansion this rate of growth was equivalent to 8,7% per year. In contrast, an inexpressive rate of growth, 0,6% per year, was observed for the deceleration and crisis of this Program.

Furthermore, the crisis of the Program contributed to increase the differentiation in productivity terms existing in the sugar cane industry. As a result, in a scene of bigger competitiveness, the technologically less prepared firms went out of business or were incorporated by the most dynamic ones (more information about initial three phases of PROALCOOL, to see: Shikida (1998) or Shikida & Bacha (1999).

Analysing the Brazilian evolution of sales of cars moved by alcohol during the 80's and 90's, after developing from 28,5% to 88,5% in the first four years of the 80's, the proportion of these cars sold surpassed 90% during the four following years. Even so, the decrease of that participation in the market would happen the following decade, already starting from 1990. While in 1994 the sales of cars moved by alcohol represented 12,2%, in 1995 the participation represented just 3%. This fact demonstrates the reduction of interest for cars moved by alcohol. Valley to remember that due to the alcohol supplying crisis and the reduction of features invested in PROALCOOL, consumers as well as the automobile industry had lost confidence, and this fact certainly compromises the present and future of the Program.

About the now "interest disagreement", in the State ambit, three points stand out: the PETROBRÁS position; the extinction of public organs linked to the sugar cane industry; and the alteration of an own profile of the State. The alcohol barrel cost is higher than gasoline, although in the fuel station the alcohol is cheaper than gasoline, but who paid (known as Alcohol-Count) is the PETROBRÁS. In 1995, the accumulated deficit reached more than US\$ 2 billion, exclusively due to Alcohol-Count. Another reason that motivates the PETROBRÁS interests against PROALCOOL is the increasing national petroleum production and the consequent decrease of external dependence concerning this important product. Another point is related to the extinction of a public organ like the IAA (Sugar and Alcohol Institute), occurred in 1990. In this case the PROALCOOL lost two institutions that could create conditions of a development balanced for this section (the extinction of IAA also implied an extinction of PLANALSUCAR, an agronomic institute that researched on sugar cane cultures). The alteration of an own profile of the State is intimately linked to the analysis of its profile, not only concerning the sugar cane industry but the entire economy. Starting from 90's, Brazil developed a State with a "neoliberal" profile, also affected by a serious fiscal crisis that, according to Goldin & Rezende (1993), forced the contention of PROALCOOL in terms of a reduction of incentives, subsidies, etc.

This State positioning also caused effects on other PROALCOOL's interest. To the industry of machines and equipment, the situation of shortage of

financing interrupted some implantation processes or amplification of distilleries, producing uncertainties that harm the commerce.

Valley to point out that the Brazilian sugar behaviour showed recuperation due to an increase of international prices. With factors such as the instability of sugar cane from countries like India, Thailand and Cuba, and due to the evolution of the Brazilian sugar industry, the Brazilian sugar exports grew again. Therefore, the sugar production became interesting to the producer in fields that still more compromise the institutional PROALCOOL scene.

In this dynamic panorama of PROALCOOL a new paradigm to stand out - the technological paradigm - because the State is retiring from the sector and stopping to grant benefits to PROALCOOL. Thus, the new interactions are doing with that some producers began adopt the technological paradigm to survive in the competitive market.

3.4. Crisis and Rearrangement of PROALCOOL (1996 to 2000)

The phase of crisis and rearrangement of PROALCOOL, verified in 1996-2000, evidences clearly that the combustible alcohol still does not have a defined position in the Brazilian energy matrix. Some pointers show this panorama: only 0,6% of cars currently produced are designed to use alcohol, whereas in the past the percentage of cars moved by alcohol reached 96% (in 1985). The alcohol production grew, but at smaller rates than in the two initial phases. Currently, the capacity installed by the sugar cane industry generates an alcohol production bigger than its demand, which means that there is an excess of supply.

The pointers against PROALCOOL are increasing, while the favourable pointers are decreasing (see table 2). However, at this moment is necessary to discuss the quality of each argument, be it a favourable one or not.

Analysing the jobs creation in the energy sector can verify that the investment for job creation in PROALCOOL presents a favourable impact (and/or low cost) for a country with the features of Brazil, where unemployment and the agricultural exodus are serious problems. Valley to remember that Brazil offers good conditions for a growing sugar cane industry, such as climate, available land, labour, and sugar cane is a traditional product in Brazil.

In reality, oil consumption and the use of cars are subsidised, because the economic costs for society in the consumption of these products exceed the price paid effectively. If the negatives externalities (not monetary damages caused by the use of cars without adequate compensation) could be measured, there would certainly be bigger possibilities to choose an adjusted vehicle with environment terms.⁴

⁴ However, “*automotive exhaust emission policies are another important ‘external’ factor which affects car fuel efficiency in IEA – International Energy Agency - countries. The primary exhaust emissions that countries have regulated are hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxides (NO_x). More recently there also has been growing attention paid to controlling lead emissions*” OECD & IEA (1984, p.49).

TABLE 2 - The evolution and phases of PROÁLCOOL.

Phase	Favourable pointers	Opposite pointers	Some indicators	Criterion of decision
First Phase Moderate expansion (1975-1979)	<ul style="list-style-type: none"> • "interests arrangement" • first petroleum crisis • the Brazilian petroleum offers is low • instability of the sugar external market • agricultural conditions • capacity installed of sugar cane industry (anidro) • environment argument 	<ul style="list-style-type: none"> • high cost of alcohol • economic crisis • others alternatives of energy (coal, vegetable oil) • low technological progress of alcohol production 	<p>1979</p> <p>% production of cars moved by alcohol = 0,3%;</p> <p>Total production Alcohol (10⁶ litres)= 3.448</p>	Subventionist paradigm
Second Phase Accelerated expansion (1980-1985)	<ul style="list-style-type: none"> • high "interests arrangement" • second petroleum crisis • the Brazilian petroleum offers is low • instability of the sugar external market • agricultural conditions • capacity installed of sugar cane industry (anidro + hydrated) • environment argument • first technological gains 	<ul style="list-style-type: none"> • high cost of alcohol • economic crisis 	<p>1985</p> <p>% production of cars moved by alcohol = 96%;</p> <p>Total production Alcohol (10⁶ litres)= 11.821</p>	Subventionist paradigm
Third Phase Decelerated and crisis (1986-1995)	<ul style="list-style-type: none"> • agricultural conditions • environment argument • more technological gains • job argument 	<ul style="list-style-type: none"> • "interests disagreement" • high cost of alcohol • economic crisis • reduction of intervention • phase of recuperation of sugar external market • the Brazilian petroleum offers is increasing • imbalance between offer and demand of alcohol 	<p>1995</p> <p>% production of cars moved by alcohol = 3%;</p> <p>Total production Alcohol (10⁶ litres)= 12.707</p>	Technological paradigm

<p>Fourth Phase Crisis and rearrangement (1996-2000)</p>	<ul style="list-style-type: none"> • agricultural conditions • capacity installed of sugar cane industry (anidro + hydrated) • environment argument • more technological gains (the technology of alcohol production is enlargement) • job argument • possible new “interests arrangement” 	<ul style="list-style-type: none"> • high cost of alcohol • economic crisis • reduction of intervention • phase of recuperation of sugar external market • the Brazilian petroleum offers is increasing • credibility of PROÁLCOOL is low • others alternatives of energy (the Bolivian’s gas) 	<p>1999 % production of cars moved by alcohol = 0,6%; Total production Alcohol (10⁶ litres)= 15.162</p>	<p>Techno- logical paradigm + envi- ronment argument</p>
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Source: data of the research

The environmental argument, stronger in the national and international context, is one favourable point to the expansion of renewable fuel programs. Currently the alcohol allows a reduction of 10% of CO₂ emissions in Brazil (Rovere, 1996). With the reduction of cane field fires and a control of “vinhoto” pollution (that can reach underground rivers and riverbeds), the result of the environmental argument certainly will good.

In the last years, the great problem of PROALCOOL was the low price of international petroleum (the price of gasoline imported – spot market - is around US\$ 0.15/litre). But the costs of a barrel of equivalent alcohol (in equivalent energy) for Brazilian producers are US\$ 50 (US\$ 0.32/litre) (Silva *et al.*, 1999). But, when one speaks about alcohol production costs, it is necessary to stand out an average of these production costs, because the Brazil presents a considerable difference between its productive units.

Simultaneous with this problem, is the intensification of the Brazilian petroleum production, occurring after the two petroleum crises with an increase of the national production from 165.000 barrel/day in the second half of the 70’s, to more than 600.000 barrel/day in the early 90’s (Olalde, 1993). Recently, the discovery of new gas sources in Bolivia and the start of the gas-pipeline between this region and São Paulo bring new questions about the future of PROALCOOL (Silva *et al.*, 1999).

These difficulties of economic competitiveness of the alcohol made the dynamic sugar cane mills or autonomous distilleries adopt the technological paradigm as a survival model in the sugar cane industry. In this context the process continued where the less technologically prepared firms went out of business or were incorporated by the most dynamic ones. Thus, during the three phases of PROALCOOL, the costs of producing alcohol fell by 45%, with potential

for a further reduction of 22% (Borges, 1996). Other technological gains had been obtained, such as: the cars moved by alcohol already have an electronic injection; in the industrial area the technological gains had been obtained in ambit of extraction, handling of the broth and fermentation, distillation and energy generation. Now, for the Program it is important to grant attention to costs, to the development of new technology and to take advantage of the by-products - for example: pulp (used as fertiliser, cellulose production, fuel for energy generation and animal feed) and “vinhoto” (used as fertiliser).

Although the technological gains reach the alcohol engines, the credibility of PROALCOOL is low. Obviously the consumers, the most important agents in this Program, lost confidence in combustible alcohol due to the imbalance between production and consumption of Brazilian alcohol (mainly during the recuperation of the external sugar market), and the benefits granted to proprietors of cars moved by alcohol decreased.

Furthermore, the crisis of PROALCOOL is linked to the fiscal and financial crisis of the Brazilian government. Lacking money for basic services such as health and education; funds could no longer be invested in PROALCOOL (in “neoliberal” conjuncture). Nevertheless, a new “interests arrangement” is appearing. The sugar cane industry is considering the following factors: union of productive class (new institutions are appearing); addition of alcohol in diesel; reimplementation of incentives for the demand for cars moved by alcohol, based on an environmental argument (creation of “green tax”); renegotiations of the debts; to give the gasoline taxes for the sugar cane industry; to increase the technological gains; and improvement of the public opinion about PROALCOOL. With arguments as the environment and defence of job, some parliamentarians are trying to construct a new “lobby” for PROALCOOL (Silva *et al.*, 1999). The State, with “neoliberal” character, and the automobile industry watch the evolution of favourable and opposite pointers. As truthful fact has that direct intervention in the sugar cane industry, like in the beginning of PROALCOOL, is no longer possible in this current conjuncture; however the sector regulation could be the output for PROALCOOL.

Now the ambient where the system interacts is not very favourable to PROALCOOL. The dynamics of this Program continues being determined for the technological paradigm and, with more emphasis, for an ecological question also. The internal interactions of agent that organise and support the Program, as well as the interaction with the external ambient are the catalysts of a new route that PROALCOOL can come to have, everything will depend on these interactions. According to the Self-Organization Theory, the system is not a steady entity and definitively ready, but a structure that is established in permanent process. It is necessary to remember that: if a disturbance takes to a structure change, meaning the loss of some structures, hardly all the structures and the proper organization are lost. However, in case of interaction to become destructive the organization as system form is lost.

Last but not least, for Shikida *et al.* (2003, p.1), the current context of PROALCOOL cannot be dissociated of the new paradigm that exists in the sugar cane industry:

With the end of the state action, the process of economic and social differentiation of the section appears not only in the two producing areas, North-Northeast and Center-South, as well as inside of these. When the competence transforms into the main participation form in the market, the productive segment divides among those with capacity to overcome the new demands and the ones that don't present that characteristic. A competitive capacity is function, in great measure, of the possibility and ability to ally with other actors that are in the section. The new paradigm that is imposed to the section is to recognize that for its development and growth, considering the institutional limitations, there is the need of the solemnity-administration, whose great challenge is to reconcile the several involved agents' interests: the sugar cane industry, the other ones that interrelate with the sugar cane industry and the remain of the society.

4. Final Considerations

This paper undertook an analysis of the PROALCOOL evolution (from 1975 to 2000) in view of Self-Organization Theory.

As a result of paper, a “bottle neck” in the productive process originated by the oil crisis gave rise to an environment favouring energy alternatives. The sugar cane industry crisis generated an “interest arrangement” that lead Brazil to opt for the PROALCOOL Program. This disturbance was an action that constituted the evolution of system, making possible the self-organization development. The PROALCOOL - initially based on the subventionist paradigm - was a manifestation found to repel the disturbance, depended for its implementation on wide government subsidies and a strong “interests arrangement”.

In the second phase (1980-1985) the disturbance and interactions was accented. The “bottle neck” worsened from 1980 to 1985 due to the second oil crisis, generating a favourable environment for producing hydrated alcohol. Simultaneously, the “interest arrangement” supported the hydrated alcohol as the most adequate energy option for the substitution of oil derivatives. Thus, the subventionist paradigm was confirmed as form found for “interests arrangement” to repel this disturbance. Through this aggravation in the disturbance that was definitely selected the route - hydrated alcohol - so that could the system repel this disturbance.

From 1986 to 1995, PROALCOOL went from a slower growth to a crisis (deceleration and crisis). The “bottle neck” generated by the oil crisis disappeared, and so did the justification to maintain corporativism around the program. Furthermore, the Brazilian sugar behaviour showed recuperation due to an increase of international prices. Thus, some producers began to adopt the technological paradigm to survive in the competitive market, because the government was retiring from the sector. As a result, the technologically less prepared firms went out of business or were incorporated by the most dynamic ones. But, the PROALCOOL already is a system that, in part, is its proper ambient. Necessary now is the Program survival without the disturbance from petroleum and sugar cane crises. The current disturbance is given by an indefinite PROALCOOL while energy program.

The phase of crisis and rearrangement (1996-2000) is presenting signs of backup of PROALCOOL. But, in this phase the ambient where the system interacts is not very favourable to PROALCOOL. Now, for the Program it is important to grant attention to costs, to the development of new technology and to take advantage of the by-products. Moreover, other forms of “interest arrangement” are appearing (as for example the proposal to create a “green tax”, with strong environment appeal). In this context, the technological paradigm plus the environment argument will be able to give a new aiming to the PROALCOOL. According to the Self-Organization Theory, the system is not a steady entity and definitively ready but a structure that is established in permanent process. Necessary is to remember: if a disturbance takes to a structure change, meaning the loss of some structures, hardly all the structures and the proper organization are lost. However, in case of interaction to become destructive to the organization as system, form is lost.

In summary, favourable arguments and opposite arguments about this Program were analysed and compared with particular reference to criterion of decision. This criterion modified in agreement with the PROALCOOL evolution and its important events, after interactions between PROALCOOL’s elements. Therefore, the future will depends also of interactions and disturbance.

REFERENCES

ABREU, P. L. A visão do setor petróleo. In: FERNANDES, E. S. L.; COELHO, S. T. (Orgs.). **Perspectivas do álcool combustível no Brasil**. São Paulo: USP - Instituto de Eletrotécnica e Energia, 1996. p. 23-27.

ANUÁRIO JORNALCANA. Disponível em: <<http://www.jornalcana.com.br>>. Acesso em: 14 de agosto de 1999

BELIK, W. **Agroindústria processadora e política econômica**. Campinas,

1992. 219 f. Tese (Doutorado) - Instituto de Economia, Universidade Estadual de Campinas, Campinas, 1992.

BORGES, J. M. Custos, preços e competitividade do álcool combustível. In: FERNANDES, E. S. L.; COELHO, S. T. (Orgs.). **Perspectivas do álcool combustível no Brasil**. São Paulo: USP - Instituto de Eletrotécnica e Energia, 1996. p. 65-76.

CARVALHO, L. C. C. de. A visão do setor sucroalcooleiro. In: FERNANDES, E. S. L.; COELHO, S. T. (Orgs.). **Perspectivas do álcool combustível no Brasil**. São Paulo: USP - Instituto de Eletrotécnica e Energia, 1996. p. 28-48.

CASTRO, A. B. de; SOUZA, F. E. P. **A economia brasileira em marcha forçada**. 2. ed. Rio de Janeiro: Paz e Terra, 1985. 217 p.

FLICKINGER, H-G; NEUSER; W. **A teoria da auto-organização: as raízes da interpretação construtivista do conhecimento**. Porto Alegre: EDIPUCRS, 1994. 84 p.

FURTADO, C. **Formação econômica do Brasil**. 12.ed. Rio de Janeiro: Nacional, 1974. 248 p.

KRUGMAN, P. **The self-organizing economy**. Cambridge, Mass., and Oxford: Blackwell Publishers, 1996. Disponível em: <<http://cscs.umich.edu/~crshalizi/reviews/self-organizing-economy/>>. Acesso em: 24 nov. 2004.

LOPES, L. A. Vinte anos de Proálcool: avaliações e perspectivas. **Economia & Empresa**, v.3, n.2, p. 49-57, abr./jun. 1996.

MACEDO, I. de C. A tecnologia para o setor sucroalcooleiro: situação atual e perspectivas.” In: FERNANDES, E. S. L.; COELHO, S. T.(Orgs.). **Perspectivas do álcool combustível no Brasil**. São Paulo: USP - Instituto de Eletrotécnica e Energia, 1996. p. 57-64.

MAGALHÃES, J. P. de A.; KUPERMAN, N.; MACHADO, R. C. **Proálcool: uma avaliação global**. Rio de Janeiro: Astel, 1991. 197 p.

MATURANA, H. R.; VARELA, F. J. **Autopoiesis and cognition: the realisation of the living**. Reidel Publishing Company: Dordrecht (Holland), 1980. p.

MELO, F. H. de; PELIN, E. R. **As soluções energéticas e a economia brasileira**. São Paulo: HUCITEC, 1984. 146 p.

MENESES, T. J. B. **Etanol, o combustível do Brasil**. Piracicaba: Ed. Agronômica Ceres, 1980.

MOREIRA, E. F. P. **Expansão, concentração e concorrência na agroindústria canavieira em São Paulo: 1975 a 1987**. Campinas, 1989. 119 f. Dissertação (Mestrado) - Instituto de Economia, Universidade Estadual de Campinas, Campinas, 1989.

OLALDE, A. R. **Desenvolvimento tecnológico e competitividade da indústria brasileira: a indústria sucro-alcooleira**. Campinas: SCTDE/FECAMP/UNICAMP-IE, 1993. 76 p. (Relatório Final - Contrato)

OECD **Environmental effects of automotive transport: the OECD compass project**. OECD: Paris, 1986. 172 p.

OECD; IEA . **Fuel efficiency of passenger cars**. OECD/IEA: Paris, 1984. 202 p.

PARRO, J. E. A visão do setor automobilístico. In: FERNANDES, E. S. L.; COELHO, S. T. (Orgs.). **Perspectivas do álcool combustível no Brasil**. São Paulo: USP - Instituto de Eletrotécnica e Energia, 1996. p. 19-22.

RICCI, R. (Coord.). **Mercado de trabalho do setor sucroalcooleiro no Brasil**. Brasília: IPEA, 1994. 176p. (Estudos de Política Agrícola, n.15).

ROVERE, E. La. Debate. In: FERNANDES, E. S. L.; COELHO, S. T. (Orgs.). **Perspectivas do álcool combustível no Brasil**. São Paulo: USP - Instituto de Eletrotécnica e Energia, 1996. p. 131-134.

SHIKIDA, P. F. A. (1998). **A evolução diferenciada da agroindústria canavieira no Brasil de 1975 a 1995**. Cascavel: EDUNIOESTE, 1998. 149 p.

SHIKIDA, P. F. A.; BACHA, C. J. C. (1999). Evolução da agroindústria canavieira brasileira de 1975 a 1995. **Revista Brasileira de Economia**, Rio de Janeiro, v.53, n.1, p.63-83, jan./mar. 1999.

SHIKIDA, P. F. A.; GUILHOTO, J. J. M. Um panorama das indústrias do açúcar e do álcool em 1980: Minas Gerais e Brasil comparados. **Revista de Economia e Sociologia Rural**, Brasília, v.34, n.1-2, p.253-284, jan./jun. 1996.

SHIKIDA, P. F. A.; MORAES, M. A. F. D. de; ALVES, L. R. A. Sugar cane agroindustry: self-management, State and neocorporativism. In:

INTERNATIONAL CONFERENCE ON AGRI-FOOD CHAIN/NETWORKS ECONOMICS AND MANAGEMENT, 4.; Ribeirão Preto (BR), 2003. **Anais...** Ribeirão Preto: FEA-USP-RP, 2003.

SILVA, J. G. da (Coord.). **Política para o setor sucroalcooleiro frente à crise:** uma proposta alternativa para o Estado de São Paulo. Campinas: mimeo., 1999. 40 p.

SZMRECSÁNYI, T. **O planejamento da agroindústria canavieira do Brasil (1930-1975).** São Paulo: HUCITEC/UNICAMP, 1979. 540 p.

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