Hot Cappuccino anyone?

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Abstract

The author shows a simple case study of a hostelry coffee machine with a clear contradiction which caused technicians in a 'leading' Spanish technological institute to get stuck for several months, in their attempts to solve the problem. Through that case, and through the author's experience in trying to spread TRIZ among industrial firms, technical research centers and universities in the Iberian Peninsula, several themes have emerged:

a) Besides the fact that TRIZ is not an easy method or theory to implement, the lack of innovative culture makes it harder to apply.
b) TRIZ helps to formulate problems
c) Accessing the right knowledge quickly is crucial to solve industrial problems and to generate 'dominant concepts'. Some tools now allow for these achievements.

The case

This is the true story of a materials technology centre in Spain that wanted to test 'the TRIZ method' by confronting it with a 3 months unsolved problem: a hostelry coffee machine, capable of serving 'solo' coffee, coffee with milk and 'cappuccino' (coffee, milk and air). The interest in TRIZ came from learning that other institutes and companies, were either applying it or trying to introduce it among their organizations. The institute acquired TechOptimizer™ as part of the test. Taking such test did not involve any budgetary problem since the regional government financed most of such 'risky investments'. As we will comment later, this fact, repeated in several cases[1], makes difficult to spread an innovative culture and to spread TRIZ as well.

The PD (product development) team of the technological institute had been dealing with the problem of making good hot coffee with milk and also good hot cappuccino in a client's standard hostelry coffee machine. The machine had some constraints due to the rigid food legislation that made for the team an almost unsolvable problem during three months or more, since they could not change almost any piece or operating conditions. A schematic [2] view is below.

[1] The author has up to present introduced, trained in TRIZ as well as implemented leading TRIZ tools to more than 1,000 technicians across the Iberian Peninsula, including nearly 100 public and private organizations. Spain's expenditure in R&D is about 0,96 % of the GNP, being among the less innovative countries in the EU.
[2] This is not the actual machine but a basic model, due to confidentiality reasons.

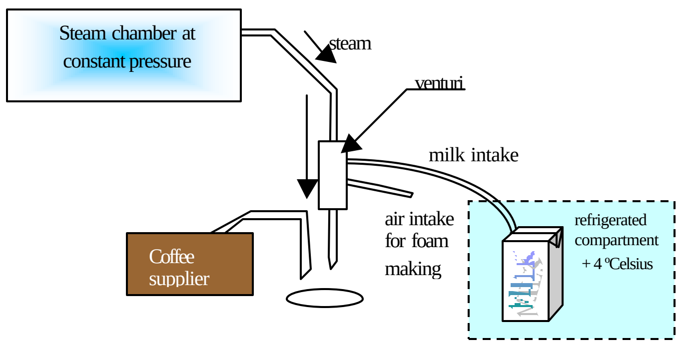

Fig 1 a schematic view of some parts of the machine

If the PD team set the parameters of the machine to obtain a good coffee with milk then the cappuccino was overheated and with bad appearance. When the team changed the machine's parameters, then the cappuccino was right but the coffee with milk was cold. For a TRIZ connoisseur, these are both tradeoffs and administrative contradictions.

Once the team examined the problem more closely they saw both situations: first the venturi sucking milk and air for the cappuccino and secondly only milk for the coffee with milk. In the second case as there was no air to suck, all the pressure decrease produced by the venturi had to be compensated by the milk and thus its quantity was excessive for the steam to heat it. If they increased the amount of steam passing through the same venturi then more milk came thus being unable to heat it properly. That's it ! Here the team got blocked by an apparent'paradox' in their own words.

The introduction of TRIZ raised the expectations of the team to solve such a problem. Within the TRIZ seminars, one of the first things introduced was the contradictions, how to formulate it, how to arrive to it, besides the concepts of 'system' etc.

Using Invention Machine's TechOptimizer™ (7), a subject-action-object, S-A-O, diagram was set for the two situations: cappuccino and coffee with milk. As a startpoit the team accepted as correct, the capuccino state:

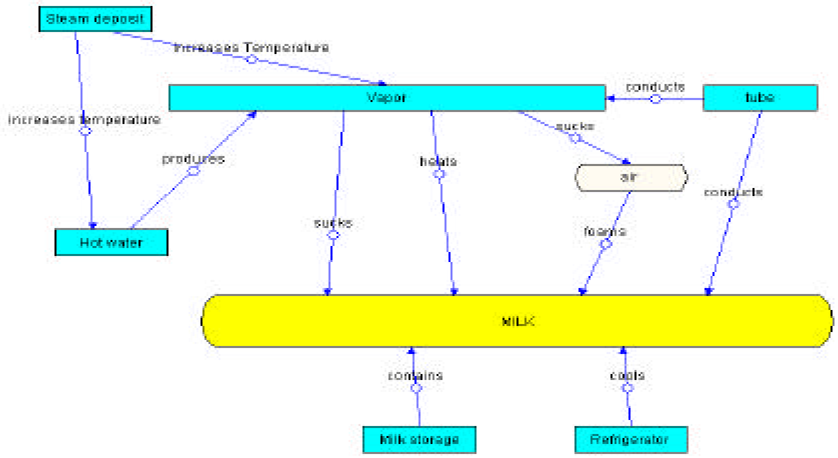

Figure 2 Basic function analysis of the cappuccino situation (when the parameters were set for a good capuccino)

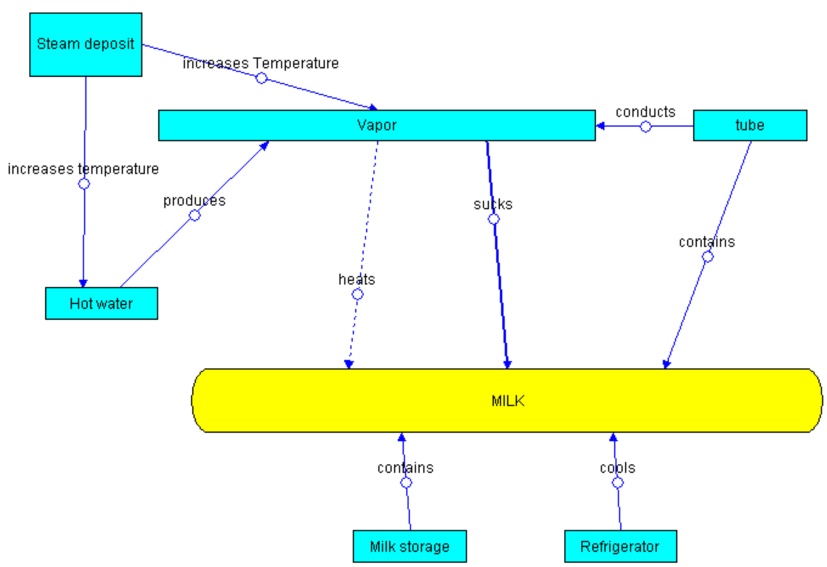

Figure 3 Basic function analysis of the 'coffee and milk' situation (when the parameters were set for a good capuccino) It can be appreciated that the heating of the steam was insufficient and to much milk was sucked.

Once the PD team learned the basics of the contradictions, technical and physical, the problem was more accurately formulated and the "what" instead of "how" was then addressed (8). Examining again the technical contradiction (the more heat coming from more vapour, sucked more mass of milk thus not achieving enough temperature) and the venturi, it was crucial to study more closely the parameters involved. At that point we could explore the contradiction matrix and the inventive principles but the study resulted in a more specific, narrowly defined problem.

In the same initial TRIZ session the team explored the ‘effects module’ of TechOptimizer to see rapidly what parameters should or should not change to solve the contradiction. Applying ASIT, this would be a typical worsening situation provoked by the variation of amount of vapour.(9)Likewise, this is similar also to the concept of ‘coupled parameters’ of axiomatic design (10). In any of the methods, it is very relevant to explore the parameters involved and the quicker the better. Therefore, having quick access to relevant knowledge is essential for the expectations of problem solving of the group, specially in the case of engineers. New tools like GoldFire Innovator™ from Invention Machine expand even more this essential access to knowledge. For the expectatives on TRIZ it was relevat for the team accessing to the adequate knowledge, without moving of the meeting table. At that point there were some members still skeptical and needing to access knowledge apart of the session would lead to questioning different ideas by trial & error instead of focusing on the contradiction.

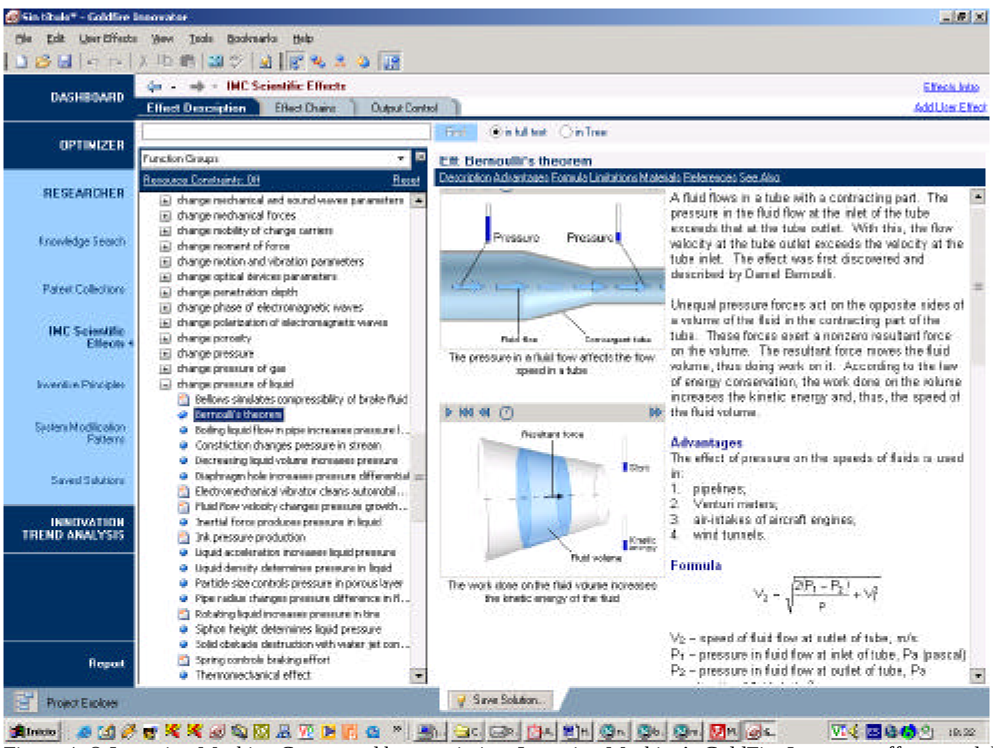

Figure 4. © Invention Machine Corp., used by permission. Invention Machine’s GoldFire Innovator effects module, gives quick, but adequate information about the phenomenon occurring

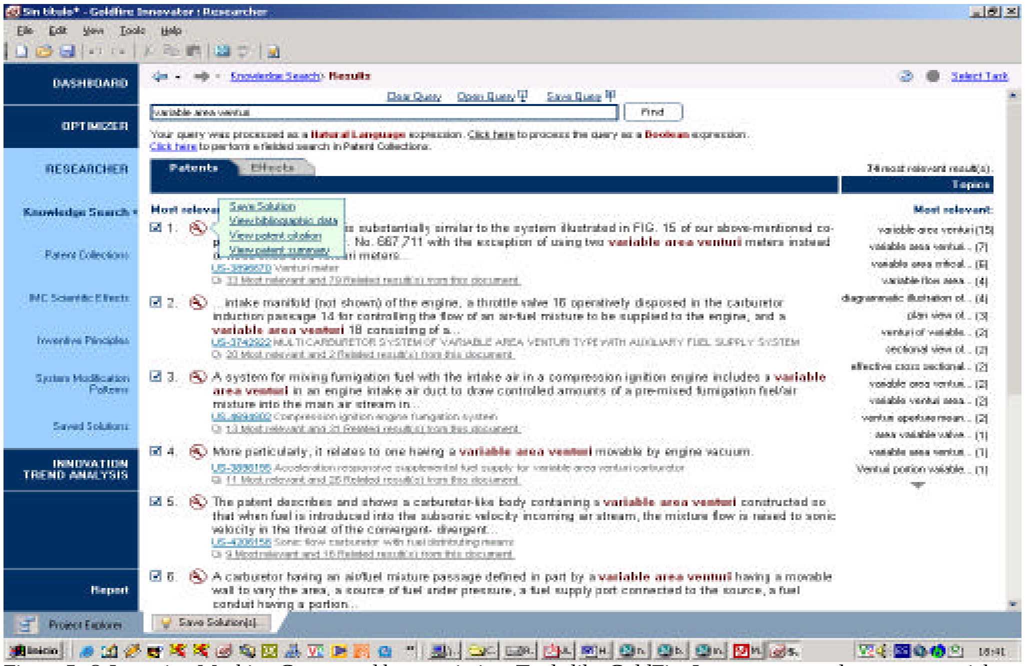

Figure 5 © Invention Machine Corp., used by permission. Tools like GoldFire Innovator expand even more quick access to the relevant knowledge. An example of venturi with a variable section (solving the PC)

Exploring Bernoulli's effect, it can be seen that what produced the void to suck the milk is not necessarily the quantity of vapour but the speed at which it passes through the venturi (keeping constant other vapour parameters). Naturally vapour is not an incompressible fluid but for the scope of the problem, the formula was very close to the reality. So we can pass more amount of vapor as long as we do not change the speed at which it passes nor the time as well.
To increase the amount of vapor passing (heat energy) without increasing the void and thus the amount of milk, the flow speed should be constant or with little change. The physical contradiction then appeared! What remains as a free parameter is the section of the venturi. Being a circumference in that case, then the diameter was the main parameter to play with. The diameter of the venturi should be as it is for the cappuccino but should expand for the 'coffee and milk'. It should be big and small.

The PD team was enthusiastic that the problem was very clear and the separation methods could be easily applied. Even trying to guess by trial and error, the number of alternatives had been largely reduced. Even for the skeptics, if they wanted to pursue the problem with their intuitive methods, TRIZ saved a pretty amount of time

Returning to the venturi, the flow of steam depended in such situation, solely of the diameter of the tube, so if we double the diameter then the quantity of vapour at the same speed is doubled. Therefore, in the situation when there is no air and all the vacuum attracts the milk, we need extra vapour to heat all the extra-milk coming, but to avoid changing any other parameter and thus avoiding the contradiction (the worsening situation- ASIT)(Op. cit.) we need to maintain time of vapour flowing as well as the speed of vapour independently of the amount of milk mass. For that we need extra cross- section or a variable one.

Addressing the physical contradiction, we could separate the opposite parameters in time or in space to name a few. A good solution was implemented and it is easily imaginable. Different approaches to overcoming the contradiction include:

Separation in time: the diameter should be narrow at before (cappuccino) and should be wide after (coffee with milk) so permitting more vapour quantity without sucking more milk, for instance by introducing a movable 'rod' inside the tube reducing the effective section. When the 'rod' (a needle valve) is outthe section is then enlarged allowing passing more vapour at the same prior speed and then without sucking more milk.

Separation in space: for instance by introducing a second tube with vapour after the venturi, etc. In this case, if we remind the OZ we explained that the venturi had two entrances: one for the milk and another for the air. When the machine was set for cappuccino then the air tube was present. IF we use the existing resources we can think to use this second tube competing with the milk but instead of air, we would use a 'modification' of air, i.e. the vapour itself ! So by slightly modifying the valve of the air and adding a bypass of the steam before the venturi, some vapour passes through it sucking milk and more vapour ! We separated the conflict in space by by-passing the 'extra vapour' needed and utilized an existing resource, the vapour.

After several months with the 'stubborn' coffee machine, the team could address new effective solutions in 1.5 hours after 6 hours of contradiction learning.

Difficulties in spreading TRIZ

The champion of the group, the Product Development Director was very excited with the results and prepared a "lessons learned" session with the principal staff of the Institute. The staff was also interested in the method and the tool, thus committing to use it and to contact their TRIZ teachers at every bottleneck.

One year after, the Institute had abandoned the usage of TRIZ, none of them pursued to learn more or reported trials with different projects. This is not rare since in other countries and organizations methodologies suffer the same story. What is different in contrast is that receiving references of TRIZ regularly they did not made any progress.

Two years after different staff members visited the Hannover and CeBit exhibition in Germany, where they met people from the Fraunhoffer Institute. According to their words they were impressed by some of the results and developments achieved by the German Institute. Once they asked about details they were surprised that TRIZ and TechOptimizer were one major factor in the results. Although they recognized they needed to refresh their TRIZ activity none of them have done so after one year and a half.

For several countries in Europe[3], public aids allow people to buy tools without a pressure to use them and this harms an innovative culture. Citing Michael Porter (11) in the diamond of competitivity, the Public Administration and Luck play a secondary role.

The author could mention two other Public Funded Technical Centers, one in the North of Spain and another in the East with very similar cases. Once they have solved a problem with the help of the author, afterwards no attempts to follow up make the people to abandon the investments made. To support such vision, the next figure shows the R&D expenditure per country, where we can see that Spain is still behind many developed countries and that its public share in R&D is still too big for a developed country. The efforts in industrial R&D are still low. Lack of staff dedicated to true R&D or conceptual design, at many firms, lets few time to spend learning and applying TRIZ.

[3] Previous experience of the author includes being EU expert in Technology transfer among countries and ten years working for a public institute dedicated to funding small and medium companies' innovation projects.

	Business enterprise	Government	Other national sources	Abroad
Belgium	66.2	23.2	3.3	7.3
Denmark (1)	58.0	32.6	3.5	5.3
Germany	66.0	31.5	0.4	2.1
Greece	24.2	48.7	2.5	24.7
Spain	47.2	39.9	5.3	7.7
France	52.5	38.7	1.6	7.2
Ireland	66.0	22.6	2.6	8.9
Italy	43.0	50.8	-	6.2
Netherlands	50.1	35.9	2.6	11.4
Austria	39.0	42.1	0.3	18.6
Portugal	32.4	61.2	2.1	4.4
Finland	70.8	25.5	1.2	2.5
Sweden	71.9	21.0	3.8	3.4
UK	46.2	30.2	5.7	18.0
EU-15 (1)	56.1	34.0	2.2	7.7
Cyprus	17.5	66.5	6.5	9.4
Czech Republic	52.5	43.6	1.7	2.2
Estonia	24.2	59.2	3.9	12.7
Hungary (1)	34.8	53.6	0.4	9.2
Latvia	29.4	41.5	na	29.1
Poland	30.8	64.8	2.0	2.4
Slovenia	54.7	37.1	1.1	7.2
Slovakia	56.1	41.3	0.8	1.9
EU-25 (1)	55.8	34.4	2.2	7.6
Bulgaria	24.4	69.2	1.1	5.3
Romania	47.6	43.0	1.2	8.2
Turkey	42.9	50.6	5.3	1.2
Switzerland	69.1	23.2	3.4	4.3
Iceland	46.2	34.0	1.6	18.3
Norway	51.7	39.8	1.4	7.1
Israel	63.9	28.8	3.4	3.8
US (1)	66.2	28.7	5.1	na
Japan	73.0	18.5	8.1	0.4

Figure 6: R&D expenditure by source of founds.
Source: DG Research Key Figures 2003-2004
Data: OECD, Eurostat

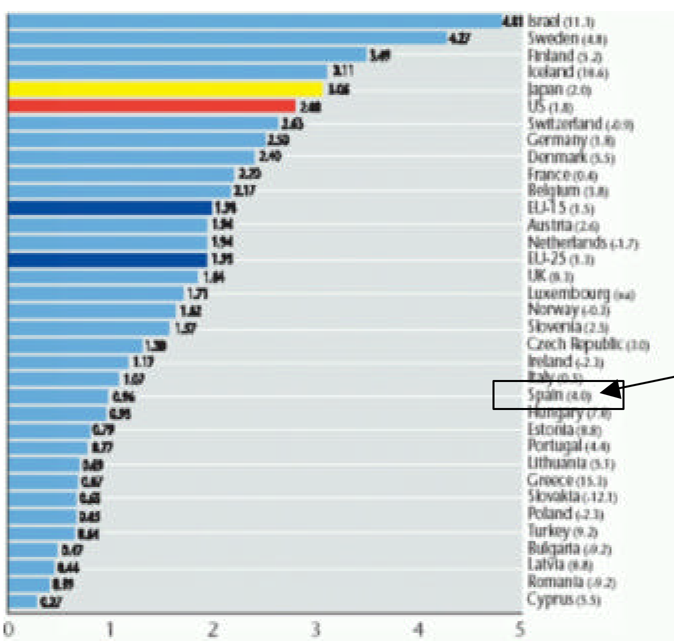

Figure 7 R&D Intensity as % of GDP
Source: DG Research Key Figures 2003-2004
Data: OECD, Eurostat

As conclusion it has been tried to show that the presence of public funds may distort the spreading of an innovative culture and may put no pressure to technicians to truly innovate, and so affecting the spreading of TRIZ. On the other hand, through a simple case the article tried to show that TRIZ do help technicians to tackle problems but as TRIZ may drive you apart from your psychological inertia, accessing new knowledge quickly is of the utmost interest.

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