TITLE The Research Cooking as Innovative Design

ABSTRACT The practices developed in some of the best restaurants in the world have transformed the way we perceive the food and, at the same time, they have implemented some operating systems focused on constant research activity. One way to understand and interpret this type of cuisine can be from the design theory. In this paper, some introductory aspects of this approach are discussed and it is showed how it is possible to modelize a case study filed in Science and Cooking Public Lectures of the School of Engineering and Applied Science at Harvard University.

KEYWORDS CK Theory, innovative design, Research cooking

The Research Cooking as Innovative Design

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1. What is Research Cooking?

The relationship between gastronomy's world and other areas has always existed in one way or another; for example, the food industry has traditionally developed tools, techniques and products. The relationship between cooking and science was consolidated in the early nineteenth century (Castells & Perelló 2000). However, it was at the end of the last century and at the beginning of this one when there was a revolution that redefined the relationships between the gastronomy's world and everything around it. This new way of understanding cooking has had as main actors Heston Blumenthal, Thomas Keller and Ferran Adrià, as well as various chefs who did stays in their kitchens and who acquired this practice focused on the research, as René Redzepi, Massimo Bottura, Andoni Aduriz or Joan Roca.

This revolution is complex and analyzable from multiple perspectives and points of view. The most impressive is the transformation of haute cuisine in a mass phenomenon, with a continuous presence in the international media. This is the case of Ferran Adrià, who during the years 2003 and 2004 appeared on the cover of The New York Times Magazine, Le Monde and Time, becoming a global reference. Paradoxically, it is not necessary to have experienced the feelings, essentially taste and smell, produced by the dishes of any of these restaurants, to develop a strong interest and admiration for this way of understanding this kind of cooking.

The key of this success could be found in the ability to transform the way as the food is perceived, and also in the development of an own speech concerning its activity.

The origin of the Avant-garde cuisine, Techno-emotional cuisine, or Research Cooking, as Vilar and Jaques (Jacques & Vilar 2012) propose to call it, could be found in the early 90's, when the team of elBulli started to understand himself as a research practice in a restaurant. In 1992, Ferran Adrià spent a few months working with the sculptor Xavier Medina Campeny in his workshop. During this time Adrià could learn the way of working of a creative person, and he could cook by investigating without the need to satisfy the service in a restaurant. In 1994 the concept of creative team began to work.
The aim of the Cooking Research is the research, to find new techniques and culinary concepts for the subsequent creation of new recipes and the invention of new tools. All the activities, organization, equipment and timing, are focused on this goal. More techniques and concepts have been created in the recent years than in the last century.

2. How the Research Cooking can be modelized?

Which operating systems are used for the research in the kitchen of a creative cook? What are the basic operations for a technical and conceptual search? And, what are the basic operations for the development of new recipes? The answer to these questions would explain the ability of this type of cuisine to transform their own identity. From this point of view, the objects produced are as important as their production systems.

The Research Cooking is an activity that modifies the reality into three-dimensional level in order to allow the development of a utility function. Its main purpose is the use, and it shares this feature with the architecture and design (Eco 1999). It is in relation to the practice of these areas where it has to be placed. As in the case of fashion, every year a new collection of recipes has to be presented. The dishes have to be reproduced more than once by people other than its creator, following precise instructions.

One way to address this question (it can be others) is from the point of view of the design, as conception and implementation of new stuff (Cross 2001). A brief chronological review can be useful to contextualize the referred academic field. Several authors (Bayazit 2004; Mogens 201; Swann 2002; Wallace 1997) agree that the first thoughts about the engineering design are found in the 50's of the 20th century. Bayazit placed the first signs of streamlining design processes in initiatives such as "De Stilj", at the beginning of the 20s, in the experience of the Bauhaus and in later influences of its teachers (Gropius, Mies van der Rohe, Moholy-Nagy,...) in the United States, in the texts of Le Corbusier or in the manifestations of Buckminster Fuller. The author hypothesizes that the seeking of design methods and techniques emerge in the wake of the Cold War and in the race to conquer the cosmos, and he indicates the influences of scientific, sociological, environmental or psychological progress of human behavior

in those aspects that could be related with design. Moreover, the first references to design methods and design methodologies are in the 60's, in some authors like Asimow, Jones, Alexander and Archer. During these years, the first congresses, seminars and conferences are initiated. In 1969 Herbert A. Simon published The Sciences of the Artificial and Rudolf Arnheim published Visual Thinking.

The Design Society organized the first International Conference on Engineering Design in 1981. During the 80's, the first academic journals appeared: Design Studies in 1979, Design Issues in 1984, and in 1989 the Research in Engineering Design. At the same decade, the books by Hubka, Pahl and Beitz, French, Cross and Pugh were published. All these references can be found in the article by Bayazit. During this decade were also written: *How Designers Think* by Bryan Lawson in 1980, *Educating the Reflective Practitioner* by Donald Schön in 1983, *Design Thinking* Peter Rowe in 1987 and in 1995 Ikujiro Nonaka writes *The Knowledge - Creating Company*.

During the last decades, several theories have been proposed, as the General Design Theory, the Gero's Design Prototypes, the Axiomatic Design, the Infused Design and Concept- Knowledge Theory, among others. References to these theories can be found in the articles of Thompson and Paredis (2010), and Hatchuel (2011). A design theory is a model of the act of design that allows the interpretation of the actions of the designer from a theoretical point of view (Thompson & Paredis 2010). PFor this reason, the Systematic Design Method of Pahl and Beitz and Altshuller's TRIZ methodology are design methods instead of design theories.

Hatchuel and Weil (1999; 2002; 2003; 2007; 2009) propose a theory, the Concept-Knowledge Theory which is based on the distinction and interaction between two spaces (figure 1) (this document is not intended to discuss the validity of the theory, but how it is formulated and to use it to explain the creative discipline practices).

• Knowledge space: represents all the knowledge available for a designer (or group of designers) at a given time. These are propositions that the designer is capable of declaring as true or false, that is, propositions whose logical status is known by the designer (for example, some phones are mobile).

• Concept space: A concept space represents propositions whose logical status is unknown and cannot be determined respect to a given knowledge space. These propositions cannot be stated as neither true nor false by the designer at the moment of their creation (for example, some phones may prevent heart attacks).

In the CK Theory, concepts are descriptions of an object in the form "C: object X exists with properties P1, P2, ..., Pn such that C is decidable respect to K". In other words, the designer who created the concept is not able to tell whether such thing is possible or not at the moment of creation. A designer can develop the initial concept by adding new properties in C. This development is called partitioning, and it can be of two types: restrictive partitions, that add up to a concept a normal

property of the object designed, and expansive partitions, that add up to a concept an unprecedented property (Hatchuel 2003). Creativity and innovation are possible due to the expansive partitions: these lead to a fundamental revision of identity (or definition) of objects. Concepts are thus created from the knowledge and therefore are relative to K. For this reason, different designers with different expertise can create different concepts.

When a concept space is elaborated, a designer might use his or her knowledge either for a further partition of the concepts, or for attempting a validation of a given concept. This last type of operation is called K-validation, and it corresponds to the evaluation of a design description using knowledge. The result of a K-validation is positive when the designer knows that the proposition "there is an object x with properties P1, P2… Pn" is true. The result is negative when the knowledge available for the designer allows him to state that such an object cannot be built. In both cases, the conception ends when the concept has been validated (or rejected). The process can also continue creating new concepts or other (unexplored) branches of the tree of concepts.

The validation of the concept is often not immediately possible. From C's partitions, some object definitions, which could not be known by the designer, have been created. To validate these concepts, new knowledge that justifies the conditions of existence of the object has to be acquired. So, the available knowledge has to be expanded. The central proposition of CK Theory is therefore, that the design is the interaction and dual expansions of concepts and knowledge (Hatchuel 1999; 2002; 2003).

3. Modeling a case study

If CK Theory is a model of the act of design, then it should be able to model the practices of the Cooking Research. In the following paragraphs a possible case is shown.

In October 2010, as part of the Science and Cooking Public Lectures of the School of Engineering and Applied Science, Harvard University, Grant Achatz made a presentation entitled Reinventing Food Texture and Flavour, in which he explained a way of thinking a receipt. Achatz's restaurant, Alinea in Chicago, has won several awards and it has appeared on the list of top 50 restaurants in the world. In the presentation, available online (Achatz 2010), Achatz shows an initial Check List, which contains the following products: Bacon, Bay leaf, Chervil, Chives, Cream, Almonds, Eggplant, Maple syrup, Olive oil, Onions, Parsley, Pork, pork Salt, Sea grapes, Rosemary, Rum, Sage, Shallots, Red wine, Béchamel, Lemon, Mint, Mushrooms, Mustard, Pink peppercorn, Hazelmats, Nutmeg, Parsnips, Oregano, Parmesan cheese, Pimentos, Mung beams, Savory, Sour cream, Tomatoes, Vinegar, Worcestershire, Walnuts, Apple, Brown sugar, Butter, Beer, Vanilla, Cheddar cheese, Chillis, Coriander, Sesame, Rice, Cumin, Garlic, Hambocks, Jalepenos, Madeira, Orange, Tequila, Locks, "Panceta", Thyme, Black pepper, Ginger, Squash, Curry, Chestnuts, Truffles, Ham, Mango, Paprika, Figs, Saffron and Mustard.

The displayed list appears as the knowledge that the cook will use to carry out the dish, in that the ingredients (properties) that will be part of it are present in the list. The chef starts with the initial idea of a receipt with white beans, figure 2A, at which he will add some ingredients from the list. First, he proposes an element that can be bacon, but also “panceta” or ham, figure 2B.

Then, he proposes to add fruit, in this case apple or pear combine well with the beans and with “panceta” or bacon or ham, figure 2C. The same thing is made with more items from the list: maple syrup, figure 2D; beer, figure 2E; almonds, figure 2F. He validates each new stage, with various combinations of the ingredients, from his taste criteria (knowledge). The figure 2F shows how almonds can combine well with the other ingredients, which at the same time are well combined among themselves; but this is not the case for red wine, which although it is well combined with some of the elements of the dish, it does not mix well with others, and therefore it ceases to be a property that can be present in the final dish, figures 2G and 2H. The final result can be seen in figure 3.

Achatz does not explain the cooking techniques he will use for each of the ingredients. For example, he decides to present beans as puree and beer as foam; but, he considered some other options? These techniques are also properties of the dish and they can be proposed as they are known by him.

As mentioned, this process can be modeled with the CK Theory. Firstly, from the elements of the list and his taste criteria, he aims to combine beans (C0) with any of these three ingredients: bacon (C11), “panceta” (C12) or ham (C13). These are the properties that the object, at this point of the process still unknown, has. The object has three possible states; the first [White beans + Bacon], the second [White beans + "Panceta"] and the third [White beans + Ham], figure 4.

In the next step, each state is expanded with the addition of two new possible properties, apple or pear. It creates six new states of the recipe (C21, C22, C23, C24, C25 and C26). C23 and C24 correspond to the set of properties [White beans + Bacon + Apple] and [White beans + "Panceta" + Pear] or what is the same, [Apple + C12] and [C12 + Pear], figure 5.

As the final dish contains bacon and apple, this is the state described in the following diagram. However, it could continue showing the other options offered by the process. In this step, a new property, maple syrup, is added, producing C33 corresponding to [White beans + "Panceta" + Apple + Maple Syrup], and so on. The whole process diagram is shown in figure 6.

At the same event, the Science and Cooking Public Lectures of the School of Engineering and Applied Science, Harvard University, Joan Roca of El Celler de Can Roca, presents a recipe in which the creative element is the olfactory notes of a wine (Roca 2010). The dish is called "mussels Riesling", and it is composed of Riesling sauce (wine and xanthan gum), and above it there are six mussels, above of which one an element associated to each aroma is placed: mayonnaise bergamot,

apple and jasmine compote, coriander and lemon, roses and nectarine with caramelized rose petal, ground distillate (obtained with Rotaval) and finally, white Piamonte truffle oil.

In the presentation appear the elements that constitute the receipt as well as the identification of the initial concept (a dish that play olfactory notes of a wine), but the sequence from which the dish was obtained is not exposed. It is easy to think that it was determined by the chef's knowledge about wine and its properties, in this case associated with bergamot, apple, jasmine, etc.... However, there is still the need to think about how these items appear on the dish; why a mayonnaise and not a foam? Why jam and not jelly? Is it better to combine the ingredients with mussels or with oysters? Or is better to combine the dish with some other type of mollusk? What are the alternatives that were proposed at the time of the search of the dish?

If the right information is available, the CK Theory enables the modeling of the design process of a recipe. This is possible from the chef's knowledge and from the addition and subtraction of properties that end up forming it. Moreover, the same theory can be used to model the invention of techniques, concepts and elaborations.
According to CK Design Theory, design is a reasoning activity that begins with a concept (an undecidable proposition in relation to knowledge) around a partially unknown object X, and it attempts to expand it to other concepts and/or to new knowledge. Therefore, the design process is defined as a double expansion of the spaces C and K by applying four kinds of operations, figure 7.

In operations KC there is an addition or subtraction of properties from K to the concepts of C, so that provisional concepts are generated by the assignation of new attributes. It corresponds to what is generally called the generation of alternatives. CK operations correspond to validations, as a test, as an experimental plan or as a prototype. Each time a concept is modified by a new attribute, it must be checked whether the new proposal is still a concept. New generated propositions can be new sources of attributes in the next partition. The KK operations correspond to the classical rules of logical and propositional calculus. Finally, the CC operations enable the inclusion and the control of the partitions (Hatchuel, Le Mason & Weil 2004).

Is it possible to identify this type of operation in the Research Cooking practices? In the example shown, the KC operation occurs when known ingredients from K are taken and are assigned to the concept of C. In this way, this operation occurs when an alternative is generated. There are many equivalent methods to this kind of action, for example, in this case, the check list. The CK operation occurs at the moment of the validation of the dish, at the time to try it for the first time. Once validated, the concept becomes a known element, and it belongs to the domain of space K. Another kind of validation corresponds to the completion of a test or to the realization of a prototype, as the plasticine models in elBulli. Operations KK and CC are functional.

This analysis highlights the importance of knowledge in the creative

process. It is from the available knowledge that it is possible to add or to remove properties to the object that is being found. Therefore, the activities related to the acquisition of knowledge and its classification and organization are essential and they should be covered by CK Theory. During the design process is often necessary to acquire new knowledge, and the way to do it is by consulting outside sources. For example, elBulli's creative teams attended courses, they traveled, and they were always studying recipes and techniques. These activities are done to gain knowledge. Faced with an interesting new proposal, the first step was to investigate if someone had done something similar in the past; this is another task that also corresponds to the acquisition of knowledge. In other fields, this type of activity is called technological watch. The catalogues and the documentary activity is some kind of organized and searchable form of the generated knowledge.

4. Conclusions

This article shows how, in the case of having the right information, the CK Theory allows to model processes in the Research Cooking. The theory is a model of the act of design that allows the interpretation of the actions of a designer, a chef in this case, from a theoretical point of view. The interpretation of the operators as alternative generation methods and as concepts validation methods allows us to understand the function of the methods used or usable in the practice of creative research. So, this approach may be also useful to develop new ways of doing things, this means, to develop other operating ways that allow creating new techniques and concepts.

Additionally, it has become obvious that the operations for acquiring knowledge are fundamental to any design activity, and they should complement the operations of the CK Theory. The project Bullipedia promoted by the elBulllifoundation is a project that aims to structure the culinary knowledge as much as possible and to present it in a useful and accessible form for anyone. It represents a collective form of collection and therefore of knowledge acquisition and at the same time it represents a K space whose elements can be activated in any future Research Cooking project.

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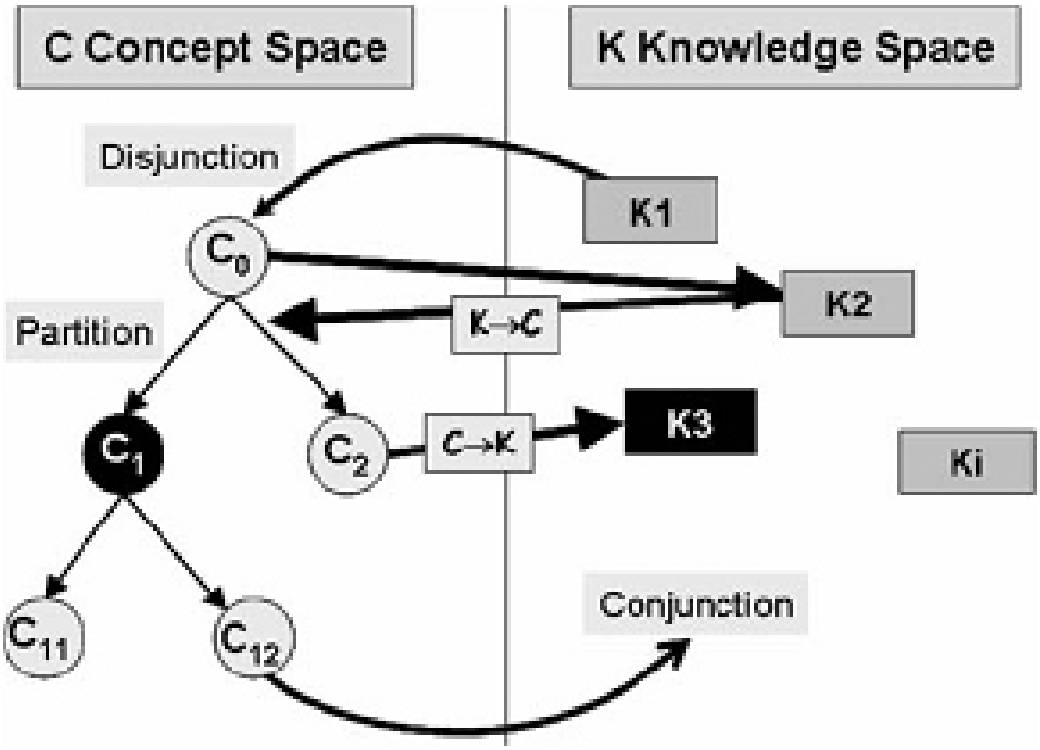


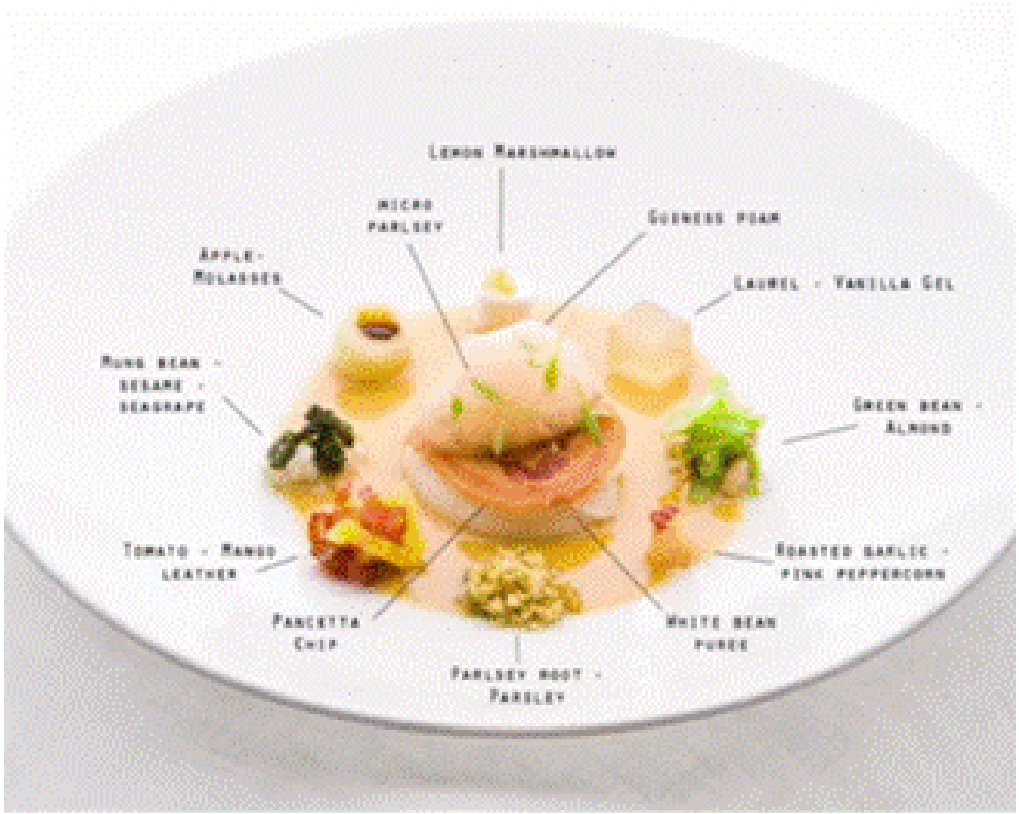


Figura 1 Diagrama C-K (Thompson & Paredis 2010)

Figura 3 Result dish (Achatz 2010)

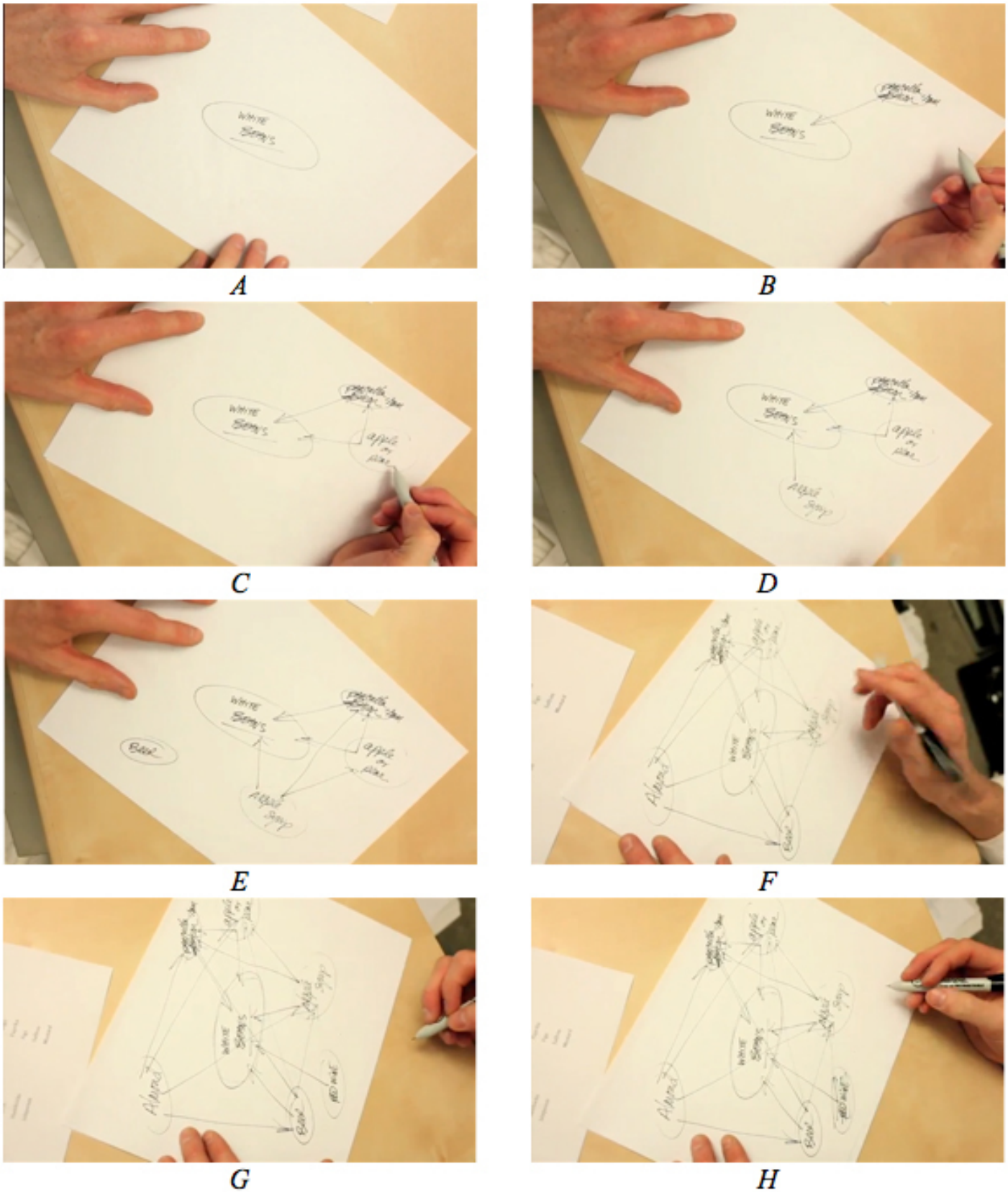
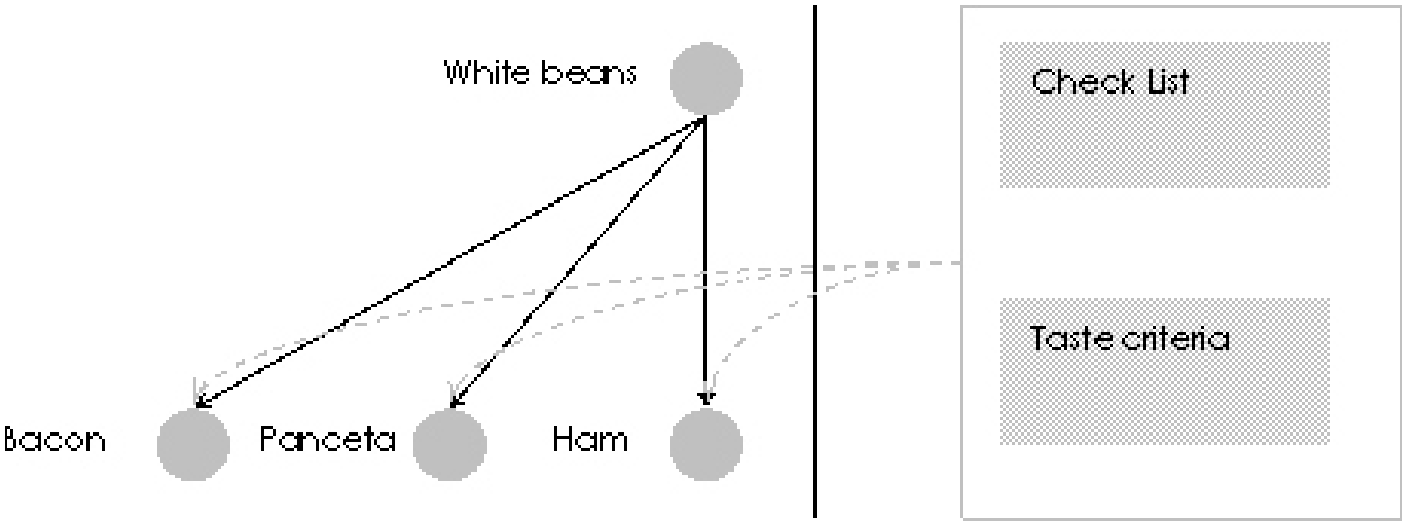


Figura 2 Grant Achatz Presentation (Achatz 2010)



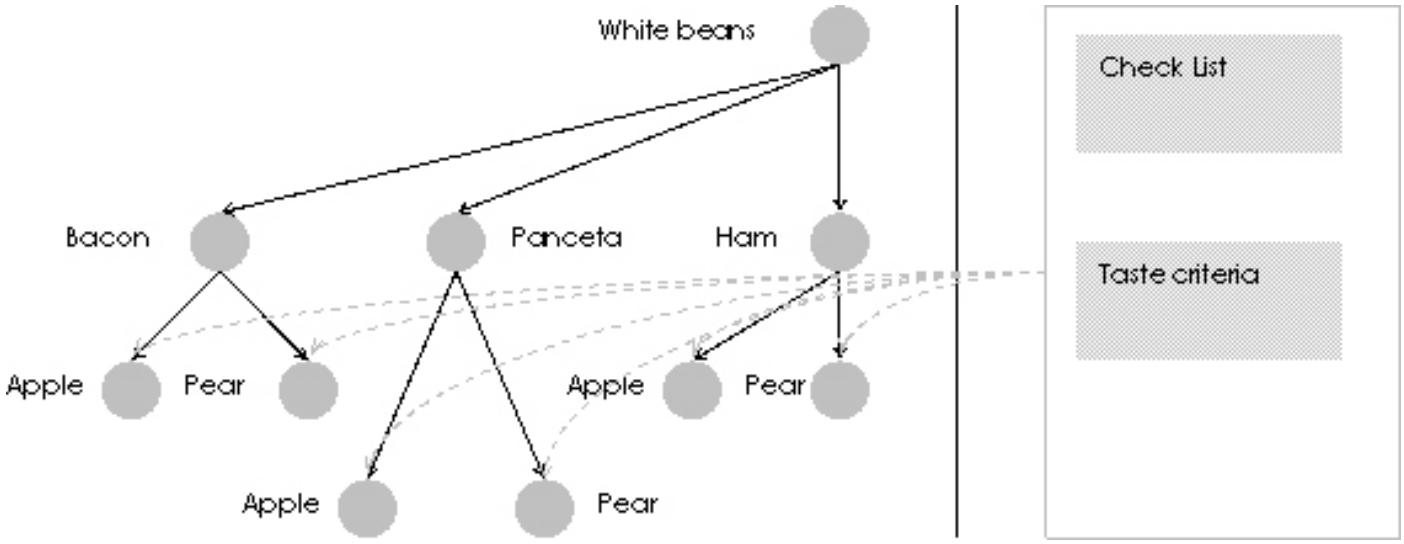
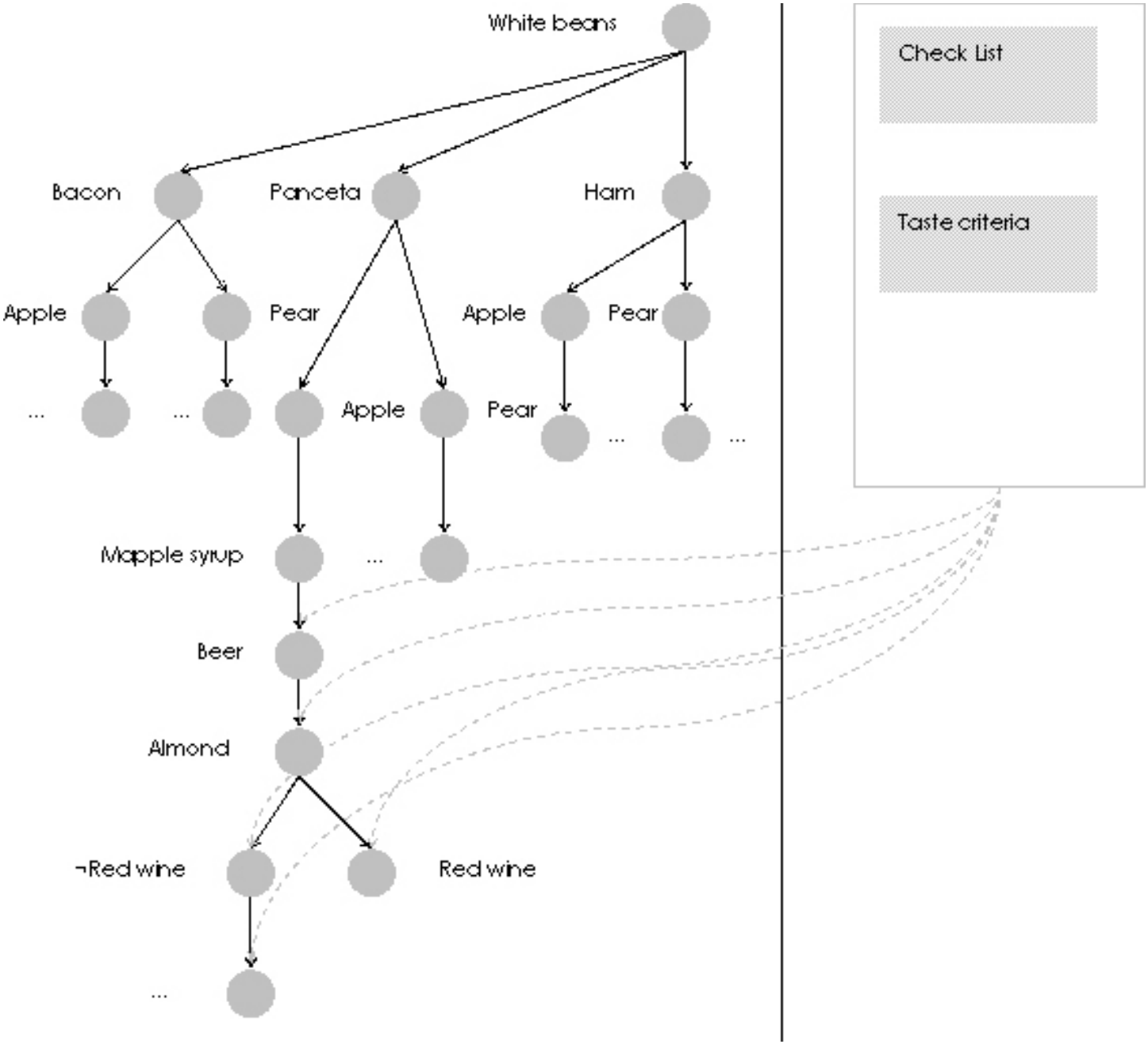


Figura 4 Diagram C-K Step 1

Figura 5 Diagram C-K Step 2



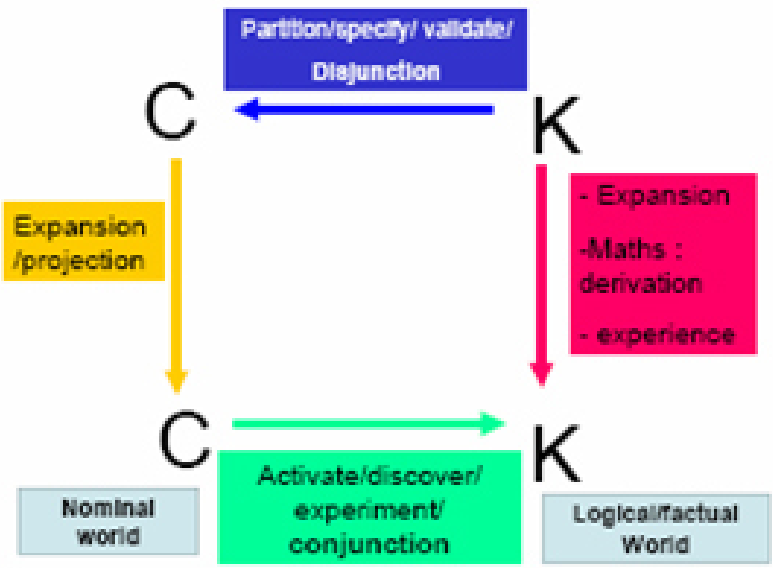


Figura 6 Diagram step 3

Figura 7 Left. CK Operators (Hatchuel, Le Mason & Weil 2004)