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Aesthetics and Robotics : which form to give to the human-like robot ?

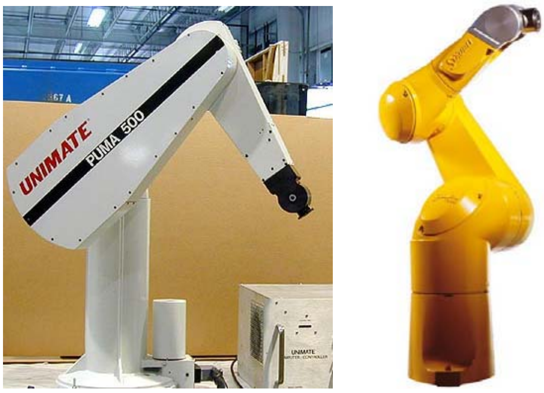
B. Tondu and N. Bardou

***Abstract*—**The recent development of humanoid robots has led robot designers to imagine a great variety of anthropomorphic forms for human-like machine. Which form is the best ? We try to answer this question from a double meaning of the anthropomorphism : a positive anthropomorphism corresponing to the realization of an effective anthropomorphic form object and a negative one corresponding to our natural tendency in certain circumstances to give human attributes to non-human beings. We postulate that any humanoid robot is concerned by both these two anthropomorphism kinds. We propose to use gestalt theory and Heider's balance theory in order to analyze how negative anthropomorphism can influence our perception of human-like robots. From our theoretical approach we conclude that an "even shape" as defined by gestalt theory is not a sufficient condition for a good integration of future humanoid robots into a human community. Aesthetic perception of the robot cannot be splitted from a social perception : a humanoid robot, any how the efforts made for improving its appearance, could be rejected if it is devoted to a task with too high affective implications.

***Keywords*—**Robot appearance, Humanoid robot, Uncanny valley, Human-Robot-Interaction.

I. Introduction

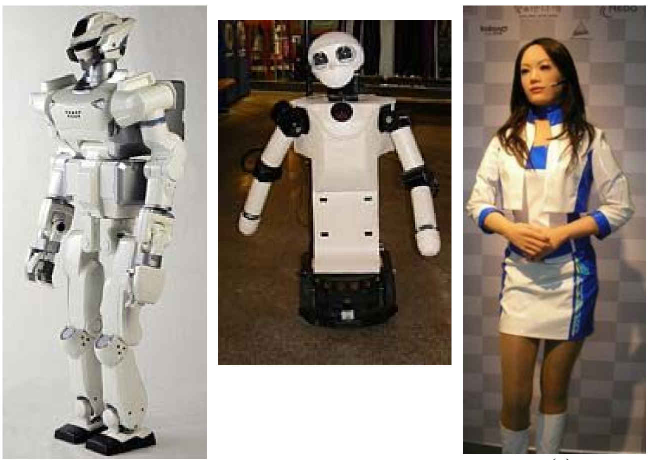
THE form of an industrial robot depends firstly on the coordinate system whose it is inspired – Cartesian, cylindrical, spherical or even multijoint with vertical or horizontal elbow joint, considered as an exotic coordinate system – and secondary on limited design choices. We can illustrate this last point with the case of the famous PUMA-560 robot; in Fig. 1.a is shown its classic form that Unimation initially gives to it and in Fig. 1.b its renewed form designed by Stäubli-Unimation when the robot became the TX-90 at the beginning of the nineties [1]. The second form with its yellow-range color is clearly closer to actual car forms when the first one denotes typical industrial design of the seventies. Fundamentally, however, these two robots look clearly like machines and their kinematic anthropomorphism is limited to the elbow joint leading to distinguish a arm-link and a fore-arm-link. On the contrary, humanoid robotics is faced to multiple choices in its attempt to mimick the human appearance. Fig. 2, in some way in opposition with Fig. 1, illustrates some of these variations in the anthropomorphic form of actual humanoid robots : on the left hand size, the



(a) (b)

Fig. 1 Form evolution of the well-known PUMA robot from its original design (a) to its actual design (b).

HRP-3 robot [2] has been inspired by Japanese robot-like manga heroes, when on the right hand size the Kokoro company's "actroid[1]" repliee Q2 [3] has been drawn like a fashion figure. Between them, the Robovie [5] illustrates a "minor" anthropomorphic form characterized by the associassion of a two-arms and head upper body with a wheeled lower body.



(a) (b) (c)

Fig. 2 Three examples of actual humanoid robots : the HRP-3 (a), the Robovie (b) and the Repliee Q2 actroid (c).

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[1] The term 'actroid' is a trade mark of the Kokoro company defined as a "humanoid robot which has made it possible to look just like a human being with an overwhelming realism and ultimate functions of expression abilities" [4].

Which form is the best one for a future service robotics ? Due to the complexity of humanoid robots, to their difficulty to program their gesture as due to simple security reasons, there are actually very few studies that investigated the relationship between robot appearance and human behavior toward them. In their recent work, T. Kanda and his colleagues [6] have compared two humanoid robots, the Robovie and the well-known ASIMO robot [7] to a human agent in a simple task without contact between the robot and the individual consisting in a sequence of four steps : first meeting, participant's utterance to experimenter, conversation for orientation to the room and navigation and conversation for guidance, as it can be expected from a guide-robot in a museum [8]. The authors conclude in particular that "ASIMO received better subjective impressions than Robovie or the human" (page 732) and further, in the paper conclusion, that "the [verbal and behavioral] differences [between the two robots and the human] were no so large" (page 734). How to understand this conclusion ? Men and robots would be in fact interchangable in certain situations ? In fact, we think that, the psychological and sociological effects of the integration of human-like machines into private or public environments is bad known first because humanoid robots are not yet truly adapted to the "real life" but also due to a lack of experimental protocol for testing the perception of those future social robots. We think that before to be able to propose a rigorous experimental protocol, it is necessary to specify a general framework for the aesthetic perception – in a large meaning – of human-like machines. We envisage to base this framework, on the one hand, on gestalt theory and, on the other hand, on Heider's balance theory. In a section II we will try to specify the anthropomorphism by distinguishing a positive and a negative meaning of this notion that can be both applied to humanoid robots. In a section III we will study how the gestalt theory could help for a better understanding of the aesthetic issue in humanoid robotics. In a section IV we will propose a social interpretation of the aesthetic issue based on Heider's balance theory.

II. Double Meaning of Anthropomorphism

In a usual meaning anthropomorphism is the spontaneous tendency of people to make attributions of human-like characteristics to non-human living or artificial beings. This tendency can be observed in a clearly way in young children's thought processes, as underlined in Piagetian tradition. Anthropomorphism of adult people would be a persistency of the "childhood animism". We don't want in the framework of this paper discuss about the psychological nature of this anthropomorphism-animism. In particular, we will evade the question of their intuitive or counter-intuitive nature. In a recent and particularly relevant paper, P. Boyer has discussed this issue [9]. According to him anthropomorphism is evidently counter-intuitive due to an "intuitive ontology" developed in the childhood from a categorical distinction between animate and inanimate objects as between living and non-living beings. But paradoxically, anthropomorphism is widespread and can lead adults to see in certain circumstances life in a car and intentionality in a computer. This paradox could be explained by the inferential potential of anthropomorphic projections peculiar to our mental ability to make inferences on the basis of cues present in our environment and also by their salient character since counter-intuitive. In accordance with the cognitive theory of cultural representations, such projections both salient and highly inferential tend to become stable and widespread. Like for any other technical being, it is so possible to give life and intention to a robot but we think the animistic phenomenon is much more strong in the case of human-like robots. In other words, a humanoid robot would associate a high inferential potential with a high salience. We can illustrate this idea on the example of the recent Hanson's head [10] shown in Fig. 3.

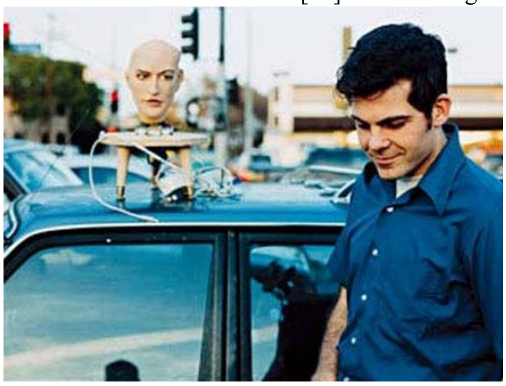

Fig. 3 Hanson's robotic head photographied near its creator.

The salient character attached to this artificial head without body but with a human-like skin is evident and still exagerated by the way it is shown on this picture; the inferential potential is directly linked to the expressive intentions that we can allocate to this artificial face.

However in the "anthropomorphism expression", this is not this anthropomorphism-animism meaning which is involved. As opposed to the anthropomorphism meaning as a mental projection on existing beings, anthropomorphism in its second meaning can be understood as the creation of an anthropomorphic form. This second approach of the anthropomorphism could be said positive anthropomorphism when the anthropomorphism-animism would be said negative since it produces no real object [11]. When industrial design gives a human physical character to some object – for example a perfume bottle – it becomes anthropomorphic [12], [13]. According to this meaning, humanoid robotics can be viewed as an anthropomorphic industrial design with a large choice of physical characters that it is now possible to mimick thanks to miniaturized actuators and sensors, micro-mechanics and polymer chemistry allowing artificial skin and molded human organs. We think, however, that the two effects of anthropomorphism, negative and positive cannot be splitted i.e. it is not possible, according to us, to give an anthropomorphic form to a machine without involving an animistic effect. Let us try to express this dependency on a systemic sheme like the one proposed in Fig. 4.

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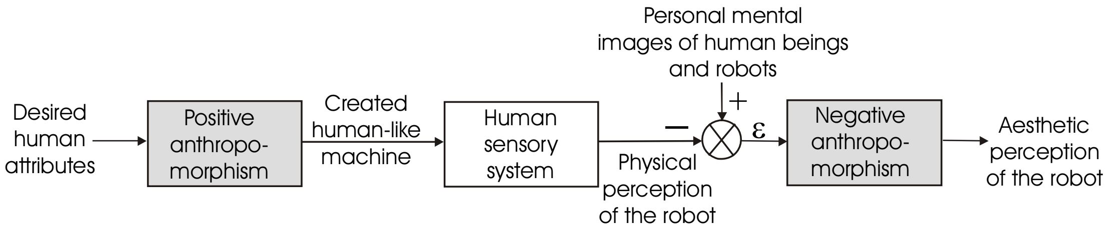


Fig. 4 Emphasizing of the double part of positive and negative anthropomorphism in human-like aesthetic perception.

On this scheme, the input of the negative anthropomorphism "sub-system" is the difference ε between the personal mental image of human beings and robots and the physical perception of the robot. We postulate that more the difference ε is small, more the negative anthropomorphism is active. This means that face to an industrial robot relatively far away from our physical appearance and behaviour, we are less inclined to attribute it in general circumstances a human intentionality but face to a humanoid robot, we are more led to give to it a human personnality in accordance with the previous cognitive approach of the anthropomorphism : the salience of the situation. This dependency between positive and negative anthropomorphism could help us to apprehend the well-known Mori's graph and its uncanny valley [14], whose we reproduce in Fig. 5 the original English version diagram. Published in the seventies in a Japanese journal, the uncanny valley – translation of 'Bukimi no Tani' is essentially a speculation about the relationship between the familiarity that a human being feels for a human form including artificial beings and the similarity understood as a human form similarity. The great idea of Mori's is to assume that the relationship is not positively continuous as it could be expected in a purely positive anthropomorphism point of view : more we are face to a human form, artificial or natural, with the attributes of an healthy person, more our acceptability of the the human form is high. But, according to Mori's uncanny valley, this continuously positive change of familiarity versus similarity is true until a point of similarity beyond which the familiarity abruptly decreases into the uncanny valley, before increasing again when the similarity bounds tends towards the 100% ultimate point corresponding to an healthy person. In his paper, Mori defines the uncanny valley as a location of fear produced by an artificial being whose the human attributes evoke more death than life. For this reason, McDorman has recently interpreted Mori's uncanny valley in the framework of a terror management theory and the resulting denial of death [15]. We think that a cognitive interpretation of the negative anthropomorphism can be a more widespread alternative to the explanation of the uncanny valley : the negative anthropomorphism would make easy to lend life to a human-like creature but the salient character of this cognitive approach can produce an attention grabing. This is such a phenomenon that we can think at work in the case of the Hanson's head of Fig. 3.

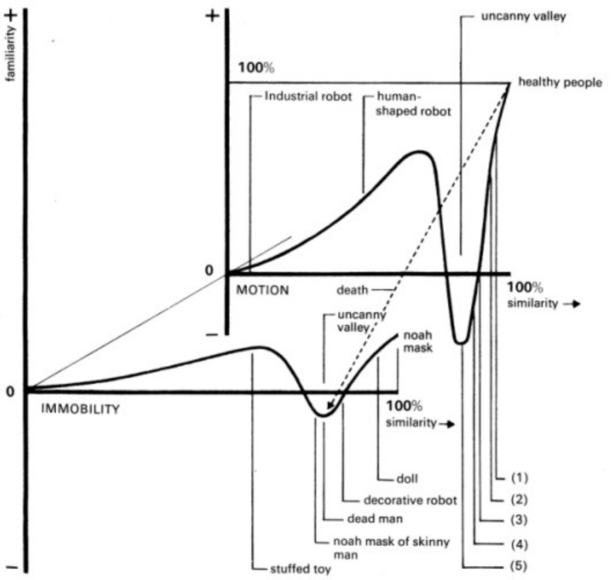


Fig. 5 Translation of Mori's uncanny valley graph as presented in Jasia Reichardt's book [16] – (1) unhealthy people, (2) Bunraku puppet, (3) handicapped people, (4) artificial electric hand, (5) moving dead man.

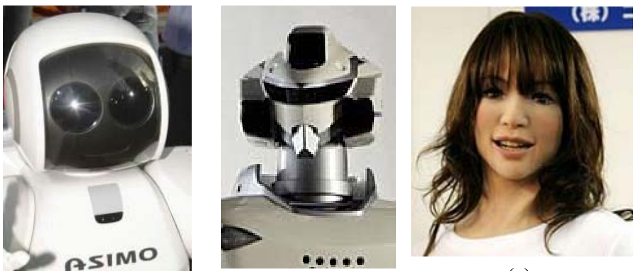
How in spite of all to specify a more rigorous frame to this interpretation ? We think that the Gestalt theory applied to the perception of the human form can be suitable for determining the specific salience of the anthropomorphic form all along the Mori's graph.

III. The Gestalt Theory Applied to the Anthropomorphic Form

Gestalt psychology is originally a theory of perception aimed to highlight a fundamental holistic principle : any perceived being does not simply result from the sum of its parts separately perceived but from a synergistic "whole effect". Recent studies have clearly shown gestalt theory is particularly adapted to the recognition of faces and expressions. Let us consider the drawings in Fig. 6 borrowed to M. White's article about the representation of facial expressions of emotions [17] : according to the author, "when the brows or the mouth are covered, the expressions seen on these face drawings are ambiguous or different from those when both features are visible" (page 372).

Fig. 6 Example of face drawings – reprinted from [17] – whose the emotions cannot be determined when their reading is only based on the perception of an isolated feature : the shape of the mouth or of the brows : when the brows are covered in (a) and (b) the two faces become identical and it is no more possible to distinguish the “sad” face in (a) from the “angry” face in (b), but when the mouth are covered it becomes impossible to correctly interpret the face expression between “angry” and “mischievous” (c).

This example illustrates the fact that a face is encoded as a “configural and holistic information” or, in other words, faces are represented as “undecomposed wholes” in which parts (eyes, nose, brows, mouth, hair, …etc) have no explicit representation. Humanoid robotics is directly confronted to this delicate issue of mimicking the holistic character of the human face. Fig. 7 illustrates the actual hesitations in the choice of a face for a human-like service robot : the “cosmonaut helmet” of the ASIMO Honda’s robot – already present in earlier P1 to P3 versions – is more a totally unexpressive mask than a true face, as it is also the case for the HRP-3 robot whose the face form has been inspired by Japanese manga comics; in opposition, actroïds’ faces with their artificial skin imagined by the Japanese Kokoro company, as the Hanson’s artificial head, try to accurately mimick the features of a human face including its carnation. All these examples can be considered as a same attempt to generate a positive synergetic “whole effect” between the artificial mask-face and the human agent i.e. an “even shape” in accordance with the fundamental idea inspired from Mach’s statement – the “part of the science is to effect economy of thought” – that our “phenomenal world” (Köhler) and our “behavioural environment” (Koffka) tends always towards an even shape.



(a) (b) (c)

Fig. 7 Variety of actual humanoid robot faces, (a) ASIMO robot, (b) HRP-3 robot, (c) AIST-Kokoro’s actroid.

This look for an “even shape” considered as the most adapted one to our thought and more especially to our social behaviour can explain the rejection into the “uncanny valley” of Bunraku puppets. As noted by R. Barthes in his famous essay on Bunraku [18], “[the] theatrical face (masked in Noh, drawn in Kabuki, artificial in Bunraku) is made from two substances : the white of the paper, the black of the inscription (reserved for the eyes). The function of white of the face is apparently not to make the complexion unnatural, or to caricature it […] *but only to efface the prior traces of features…* ” (italicized by us). Fig. 8.a illustrates Barthe’s purpose.

(a) (b)

Fig. 8 Examples of non-natural features in traditional Japanese theater, (a) Head of a Bunraku puppet whose the artificial character is exagerated by a feature effacement, (b) Noh-mask of an old man producing an uneasy feeling by a strong bilateral disymetry (from Geneve’s ethnography museum, oriental collection).

According to gestalt theory, this disparition of face features is an obstacle to the synergetic “whole effect” for identifying expression recognition. It could be also mentioned the kabuki whose the actors paint their faces to resemble the bunraku puppets. As explained by J.P. McCormick, “The kabuki presents to the world the mask-like face neither the mask nor true face but a combination of elements of each” [19] (page 200) whose ambiguity obligatory limits the natural “whole effect” interpretation. An extreme kind of Japanese theater is the Noh theater whose the stylized masks impose a formal code to the actor play; as said by McCormick, “[Noh theater actor’s] gestures have little relations to natural body movements that usually accompany such acts and emotions. […] The mask is used to create a feeling that is mainly stylized” (page 200). It is interesting, as illustrated in Fig. 8.b to remark that a Noh mask can deny a fundamental aspect of any human face “even shape” : its bilateral symetry. In comparison with these Japanese theater maks or “mask-like face” whose the knowledge has perhaps influenced Mori’s thought, the Fig. 7 humanoid robot mechanical faces seem to be in accordance with “even shape” principles of symetry. It could be even thought that the Kokoro young and pretty woman face is a perfect artificial “even shape” for a human face and so, any uncanny effect could be avoided by means of a relevant choice of an artificial robot face. The surprising picture of Fig. 9 aims to emphasize the new possibilities of artificial skin and artificial face features in such a way it is not possible to distinguish the true artificial face (on the right hand side) and the android (on the left hand side). Let us how remark that this confusion between the real and artificial worlds is actually limited to static appearance due to the difficulties to mimick the human dynamic appearance. Nothing precludes however to imagine future humanoid robots able to mimick the human dynamic complexity.

Fig. 9 Static confusion between a human face and an actroid face.

However, this view point forgets a fundamental aspect of a face and more generally of the body as a whole : the social relation that it implies. In fact, any aesthetic perception cannot be separated from a social perception[2]. This is a consequence of the negative anthropomorphism defined in paragraph II understood now as a "segretated whole" in the meaning of Köhler to be combined with the purely whole effect of human face features. Humanoid robotics is then face to a dilemna which could be called the **animate/inanimate dilemna** : a robot is naturally a complex jointed animate structure but its animation generates a social-like perception i.e. the perception of the human-like machine as it was a social person engaging us in social relations. This social-like perception which in the gestalt theory vocabulary corresponds to a "physiognomic perception" [20] can put into work both the animated face and the whole body gesture. The resulting behaviour is perceived as an affective whole in which tertiary features predominate. The new question is now how is managed this perception ? As mentioned as soon as 1969 by H. Blocker, " the enormous complexity of our ordinary perception in terms of 'physiognomic' and 'geometric-technical' perception has been already suggested. There are elements of both types of perception, surely in ordinary perception, but in what way are they mixed ? Is the perception of the man on the street identical with that of an engineer qua engineer, and if not, how does it differ ? Is the perception of an artist identical with that of a child or a primitive, and if not, how does it differ ? " [20] (page 387). We could say to parody H.Blocker : how the perception of a robot by a person differs from the perception of the man on the street ? This is Heider's social balance theory which is going to give us the possibility to answer to this question.

[2] We use here the notion of "social perception" in the meaning proposed, for example, by G.Ichheiser : "By 'social perception', we shall understand […] any kind of consciouness or awareness concerning other persons as well as any social relations among them" [21] (page 546).

IV. Social Balance Theory and the Acceptation Issue of The Human-Like Machine by People

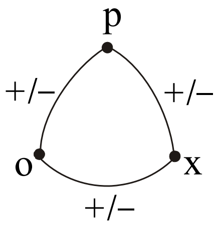
Theories of cognitive consistency or psychological balance have been initiated by Heider with his historical article on the psychology of cognitive organization published in 1946 [22]. Heider introduces the fundamental idea that certain cognitive perceptions of interpersonal relations are "balanced" while others are "imbalanced" and that imbalanced cognitive perceptions in the mind of a given actor generates a psychological pressure towards balance. If this pressure towards balance is blocked, a psychological tension results[3]. More accurately, Heider considers the case of a fundamental triad he notes (p, o, x) where p is a person, o another person and x an impersonal entity 'which may be a situation, an event, an idea, or a thing, etc.' [22] (page 107). Heider proposes to analyze the influence of attitudes towards persons and causal unit formations by defining two kinds of relationships between them : on the one hand, a positive or negative relationship of a person to another person or impersonal entity that is written L (for likes or loves) if it is positive or $\sim L$ if it is negative, on the other hand, a relation "unit" written by U (the following examples are given by Heider : 'similarity, proximity, causality, membership, possession, or belonging. pUx can mean, for instance, p owns x, or p made x' (page 107) [22]. According to Heiders' theory, relations of L-type and of U-type can be associated in a same cognitive organization whose the balanced or imbalanced state depends on their valence. The fundamental Heider's hypothesis is the following one :

> '(a) In the case of two entities, a balanced state exists if the relation between them is positive (or negative) in all respects, i.e., in regard to all meanings of L and U.
> (b) In the case of three entities, a balanced state exists if all possible relations are positive in all respects' (page 110) [22]

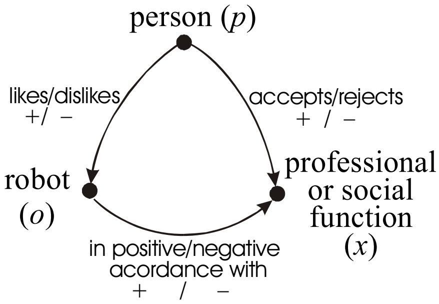
Heider's theory has been made popular by Cartwright and Harary [24] which noted that the application of signed graphs could result in a very simple definition of balance. Let us consider the '*pox*' model. We will note with either a sign '+' or a sign '–' the positive, respectively negative, relation between the entities p, o, and x. This social model can be represented by a simple graph whose the vertices are the three entities p, o, and x, as illustrated in Fig. 10.a. According to Heider's theory, the three-entity *pox* is balanced if the product of the signs associated to the corresponding graph is positive. Let us apply the *pox* model to the relationship between a person (p) and a robot, considered as an artificial other person (o) via a professional or social function (x). According to Heider's terminology, the relations between p and o and

[3] Heiders's balance theory can be viewed as a particularly elegant formalization of naïve psychology as synthesized by Heider himself in his aphorism : "my friend's friend is my friend/my friend's enemy is my enemy/my enemy's friend is my enemy/ my enemy's enemy is my friend" [23]. We think that this naïve psychology is can also be applied to any human-like machine.

between *p* and *x* are *L*-type relations (likes or does not like) when the relation between *o* and *x* is a *U*-type relation which can be defined as follows : *oU*/~*Ux* means that a *robot* is/is not in accordance with a given *function*. Fig. 10.b gives the corresponding graph.



(a)



(b)

Fig. 10 Representation of the Heider's *pox* model as a signed graph (a) and its application to the social interpretation of the relationship between a person (*p*), a social activity (*o*) and a robot (*x*).

Let us assume a positive attitude of the person *p* for the considered function *x*, and let us consider that the attitude of person *p* for the robot *x* can be positive or negative and that the relation of accordance of the robot for the function can also be positive or negative. There are in consequence 4 possible configurations of the current relations as described in Table 1.

Table 1 Possible combination of relation sign in the Fig. 10.b triad when then person-function relation is supposed to be positive

person-function (*px*)	person-robot (*po*)	robot-function (*ox*)	Relation state
+	+	+	Balanced
+	–	+	Unbalanced
+	+	–	Unbalanced
+	–	–	Balanced

acceptation of the robot jugded to be adapted to the function

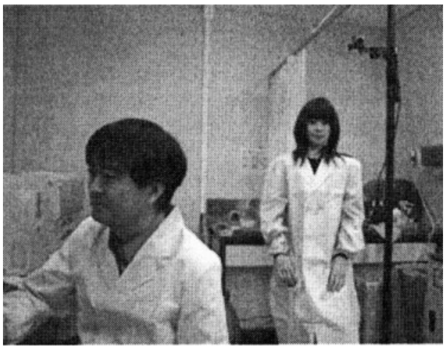
rejection of the robot jugded to be inadapted to the function

It appears clearly that the situation is balanced when the '*px*' and '*ox*' relations have the same sign i.e. when the robot perception is similar to its functional adaptation perception. On the contrary an unbalanced state results leading either to reject a robot non-adapted to the envisaged function, either to accept a robot which appears to be in accordance with its function. Finally Heider's balance theory highlights a fundamental rule of social integration of a human-like machine : people accept robots if they are perceived in accordance with their function – case (*po*, *px*, *ox*) = (+,+,+) in Table 1.

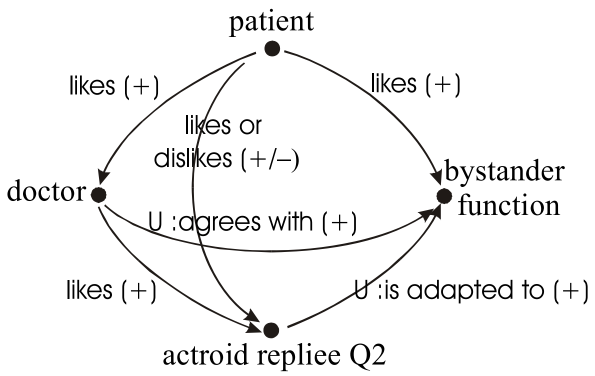
What however makes the robot a specific agent in this triad combination Individual-Robot-Function ? In a previous paper [25] we have highlighted the importance of the body-soul issue in the case of a humanoid robot : any human-like machine is potentially dissonant – in the Festinger's meaning which corresponds in our Heider's graph to an imbalanced situation – due to the fact that the agent face to the humanoid robot needs to assume it has some soul to engage the social interaction with it. The uncanny valley would be the consequence of the social quasi-impossibility to communicate with some being without admitting it has a soul. The zombie at the bottom of the uncanny valley would so appear as the ultimate frigthening figure of a pure body deprived of its soul. This approach leads to propose a fully cognitive interpretation of the Mori's graph which seems to us more relevant that McDorman's terror management theory-based interpretation. A consequence of the human-like body-soul issue is the task-dependent acceptation of the robot; we think that the "soul level" that we must give to a machine depends on its expected function : higher is the level, higher will be the unesay feeling face to the robot. The positive/negative values on Fig. 10.b graph are there interdependent. In particular, if we assume a positive value to the robot (*o*) – function (*x*) relationship the situation can however stay unbalanced if the link person (*p*) – robot (*o*) cannot get a positive value due to the impossibility for the individual to give to the robot an affective value in accordance with the robot function. This point is all the more important that future humanoid robots are aimed to work in professional fields implying affective exchanges : nursery, geriatry, … etc. We think so that the balance state of the triad '*person-robot-function*' depends on the task programmed for the robot. For example, Fig. 11's picture, taken during the 2005 Aichi International Exhibition in Japan, shows the actroid Repliee Q2 supposed to be an hostess giving informations to customers in a store : the social exchange is short, less affective and after having got its information the robot-agent can be quickly forgotten. It seems to be relevant to think that in such professional situation, the robot can be accepted for its task and the resulting considered triadic graph balanced.

Fig. 11 Repliee Q2 as an hostess robot.

The same Repliee Q2 has recently be engaged in a task with emphaty and consequently more affective between the robot and the human agents : to be a bystander during a clinical examination between a physician and a patient. Osaka's university researchers hope thanks to a "chameleon effect" – which refers to non-conscious mimicry of the partner in bilateral communication – to make the interaction doctor-patient more positive. In reported experiment [26], illustrated in Fig. 12, the actroid is placed behind the doctor which faces to the patient whose the nod and smiles are mimicked by the bystander. The situation can be expressed by the following *pox* model enlarged to the four items : doctor, patient, robot and function.



(a)



(b)

Fig. 12 Use of the repliee Q2 as a bystander during a clinical examination (the patient is face to the doctor), (a) Photography of the experiment (reproduced from [26]), (b) Attempt to represent the corresponding 'Doctor-Patient-Actroid-Bystander function' by a Heider's *pox* graph.

Let us suppose that all relations *L* and *U* are positive excepted the relation '*patient-actroid*' which can be positive or negative, i.e. the patient can likes or dislikes the presence of the robot. Heider's historical paper does not consider groups of more than three people but the formalization of Heider's theory by Cartwright and Harary by means of graph theory has recently led to a powerful *structure theorem* [27] :

> "A graph (network of individuals) within a large group of people is balanced if and only if the group can be divided into two subgroups (two sets), wherein individual relations in the same subgroup are all positive (all edges between vertices in the same set are '+' and between individuals in different subgroups are negative (all edges between vertices in the different sets are '–' "

If we apply this theorem to our 4 elements graph, it is clear that a negative relation between patient and actroid makes the graph unbalanced. In consequence, the part of the 'chameleon effect' , if it is supposed to be sufficient to prevent any dislike feeling between the patient and the robot, could be understood as a positive reinforcement of the global balance of the social situation betwwen a doctor and his/her petient. This is suggested by the conclusion reported in this paper. Can we then think that any situation involving human agents and humanoid robots is potentially balanced ? Let us now imagine a nursery robot or a "geriatric" robot working in a nursing home for elderly people. It is in this case much difficult to consider that, even for simple social exchanges, the robot could take the affective part of a human agent. Furthermore, even if beyond any moral consideration we consider that a young child or an elderly person could see the robot as a positive agent, due to a supposed high animistic process, the balance state could then depend on the family – considered as a single element in Heider's graph – responsible of the dependent patient trusted with the nursing home, as we illustrate it in Fig. 13.

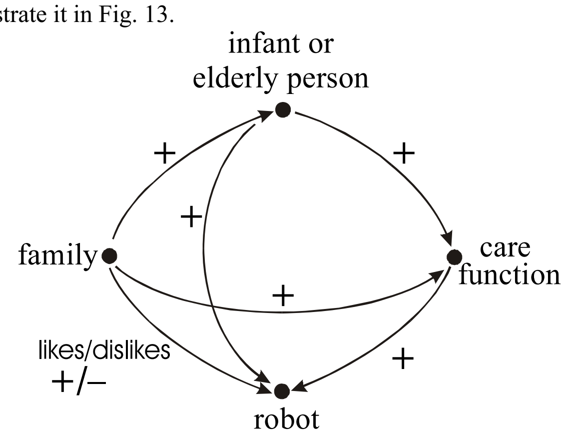


Fig. 13 Heider's graph modelling the typical relations in a care function of an infant or a elderly person by a future humanoid robot : if the family dislikes the robot the graph is unbalanced.

A negative value of the relationship '*family-robot*' makes the cycle '*individual-family-robot*' unbalanced and because the relationships '*family-infant/elderly person*' as '*infant/elderly person-robot*' have no reason to change from positive to negative, a new balance in the structure imposes to reject the robot. It appears in consequence difficult to split the aesthetic perception of the robot from its social integration and more particularly from the task in which it is engaged. In some way, the young and pretty actroids proposed on the Kokoro commercial web site whose Repliee Q2 is the "great sister", even if we give to them all technical ability needed by the task, keep soulless machines. The negative anthropomorphim, as defined in section II, can give to them a living expression but not a soul.

V. Conclusion and Future Work

We have attempted to propose an original analysis of the complex issue of the humanoid robot form. This question is fundamentally associated to our animistic-anthropomorphic thought. The anthropomorphic form given to the human-like machine understood as a "positive" anthropomorphism cannot been indeed separated from a "negative" anthropomorphism attributing to the robot human characters. We think however that this widespread animistic anthropomorphism that can be developed for any complex machine takes a specific character in the case of a human-like machine. Gestalt theory according to us can help to better understand this phenomenon. In particular, the notion of "even shape" attached to our holistic perception seems to us essential to apprehend how a human-like machine is perceived by a human agent. We have in particular analyzed the robot face and the multiple possibilities for the robot designer to get a physical "even shape" : bilateral symetry, synergetic effect obtained with mask-like faces, young and healthy faces considered as a model of beauty; but the great interest of this "even shape" principle for robots is linked to its application to both static and dynamic appearance of the machine: the face features but also the limb gesture. A non-natural or jerked arm or hand movement corresponds indeed to a non-"even shaped" behaviour because it is not in accordance with our perception of an healthy person[4]. In some way the gestalt approach seems to be in accordance with the Mori's graph and its uncanny valley : non-symetrical theater mask-faces, handicapped or unhealthy people are all examples of items chosen by Mori to be placed along the uncanny valley. However, if the gestalt theory was the alone aesthetic theory for understanding the Human-Robot-Interaction (HRI), the uncanny valley effect would disappear by means of a judicious choice of face and assumed that all technical problems of locomotion and gesture control being solved. We think that this cannot be true because the relationship between a humanoid robot and a human agent has a specificity associated to a soul-body problem : how to feel good with a machine working for us and like us, to which our natural anthropomorphism attributes to it all human-like characters but deprived of soul ? According to us the form issue of the human-like machines is not a purely aesthetic issue. We think that to be balanced, in Heiders' meaning, any relationship between the robot and a human agent must take into account the choice question of the robot function. We postulate that if the function to be performed by the robot necessitates a close, affective, relationship with a human agent, the risk of rejection of the robot is high. Because we imagine in a near future robots in hospitals or nursing homes for elderly people a future work would consist to specify tests for determining what tasks are the most acceptable for a large public.

[4] It has, for example, been remarked that the light jerky movements at the joints caused by the pneumatic actuators of the 9 d.o.f. upper limb of Repliee Q2 was a source of misfeeling for the robot's public.

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