A WWW Information-Seeking Process Model

Susanne Loeber and Alexandra Cristea
Technische Universiteit Eindhoven
P.O. Box 513, 5600 MB Eindhoven, The Netherlands
{s.g.loeber,a.i.cristea}@tue.nl

Abstract

In now-a-days information society, most people use the Web for information retrieval. The correct modelling and interpretation of this *information seeking process (ISP)* is an extremely hot topic among website designers.

We aim at investigating, analysing and modelling the user behaviour during WWW navigation, as well as their associated goals and tasks. These aims are towards establishing a framework of rules and guidelines for website design to enhance user goal fulfilment and thus user satisfaction.

This paper's novelty relies in not only the merging of various ISP models, but also in analysing and integrating the model of the driving forces behind it, such as needs and motivation.

Keywords: WWW design guidelines, ISP model, user/author persona model, MAO model.

1. Introduction

Seeking on Internet is not always easy. Users often cope with difficulties (*lost-in-space* syndrome, cognitive overhead, closure, distraction).

By knowing *how* users proceeds in WWW information gathering, but, more importantly, *why*, web site design can be modelled accordingly. Moreover, tools can be built to automate (at least partially) and predict ISP steps, thus simplifying and minimizing the search (e.g., intelligent search engines, automatic students [7]).

We are interested in website design, with special focus on investigating ways to make websites more user-friendly for different types of users. We divide our goal into four major sub-goals:

1. To *specify user information* that characterises user navigation behaviour over specific website(s).
2. To *classify websites* and types of *paths* that designers use for user guidance.
3. To find ways to *evaluate user behaviour* on different 'types' of websites.
4. To *extract Web design rules*/ guidelines.

This paper embarks on an analysis in support of the above sub-goals, starting with the first one. We focus on describing features that can affect user behaviour whilst navigating the WWW and thereby obtain a refined ISP model. We expect that knowledge about the type of need that motivates a user's search on the WWW is a key to finding an adequate description of user behaviour and mapping behavioural instances over average user behaviour. Therefore we follow here the effects of information need on the ISP.

2. Gathering User Information

2.1 User features

There are different views on what user features are relevant to interpret, to better react to each user's actual needs. Brusilovsky [1] describes five features used by adaptive hypermedia systems: *user's goal, knowledge, background, hyperspace experience* and *preferences*. De Troyer [8] divides users by *geographical, demographical* and *psycho-graphical criteria*. Turk [17] describes user characteristics according to usability evaluation: *age, gender, culture, disabilities, educational level, WWW/IT experience* and *interest/expertise*. Zeldman [18] groups websites' audience based on needs and goals into: *do-ers* (people using tools to accomplish task(s)), *readers* (people who seek entertainment/relaxation) and *viewers* (people who regard a web site as a book).

2.2 The MAO Model

An interesting model that digs deeper into the reasons and drives of user behaviour is the MAO (Motivation Ability Opportunity) model [12]:

1. *Motivation*: inner state of arousal; energy for goal achieving; factors: personal relevance, values, goal, need (tension caused by distance from desired physical/psychological state) perceived risk, inconsistency with prior attitudes.
2. *Ability*: extent of consumers' action resources (know-how, money).
3. *Opportunity*: acting chance when easier (than usual); factors: time, distraction, information amount, complexity, repetition. (local minimum on constraints surface).

MAO is relevant to a wide variety of user behaviours, e.g., WWW navigation, and is affected by factors as above. Consequences of high MAO levels include goal-directed behaviour, intensive information processing and decision-making, deep engagement.

Therefore, in a complete set of rules and guidelines for website design, the MAO model plays a vital role.

2.3 Needs modelling

We believe that the integration of a needs model within a general information seeking model is vital in expressing the triggering forces of WWW search. We distinguish three types of needs in social or non-social situations [12]:

	Social	Non-social
Functional needs:	modelling, support	safety, order, physical well-being
Symbolic needs:	status, affiliation, belonging, achievement	self-control, independence
Hedonistic needs:	Reinforcement, sex, play	sensory stimulation, cognitive stimulation, novelty

These allow us to describe the information-seeking phase more precisely.

3. WWW ISP Models Critique

Before we can build our own WWW ISP Model oriented towards fulfilling user's needs, we review and discuss current WWW ISP models, showing their strong and weak points.

We first studied stereotype WWW users's navigation, browsing and searching behaviour [4,13,15,16]. In the literature [1,3,9,12] navigation is part of the ISP model. We define WWW navigation as travelling from one web page to another, in order to fulfil a functional, symbolic or hedonistic need, either of a social or non-social nature, driven by Motivation and the knowledge of being able to find the needed information (Ability) without too much interference from the environment (Opportunity).

This activity is usually performed by oneself. However, the Internet could offer more with the right navigation tool / server. A user can e-mail others to find something, but could also use social navigation, where users navigate while

interacting with others [9,10]. Raghavan [14] estimates the average number of steps to find necessary information in the social net at 7 – so quite short.

Next, we outline some navigation models and discuss the missing relevant user information.

3.1 A general ISP

ISP has 3 steps ([3], Figure 1):

Step 1: the user has a problem, uncertainty, ambiguity or is curious about X (knowledge gap / (perceived) information need - discarded/fulfilled). To fulfil it, s/he starts seeking relevant information.
Step 2: the user searches on search engines or browses web-pages for that information.
Step 3: Once this information is found, the user will use it to fulfil the need.

This model considers cognitive, emotional and situational influences, but doesn't reveal *why* the user needs information.

3.2 Jul, Furnas and Spense model

This model [13,15] gives a clear and simple step-wise ISP version (Figure 2):

1. *form goal*
2. *decide strategy*
3. *acquire data*
4. *browse*
5. *assess*
6. *form conceptual model*
7. *act*

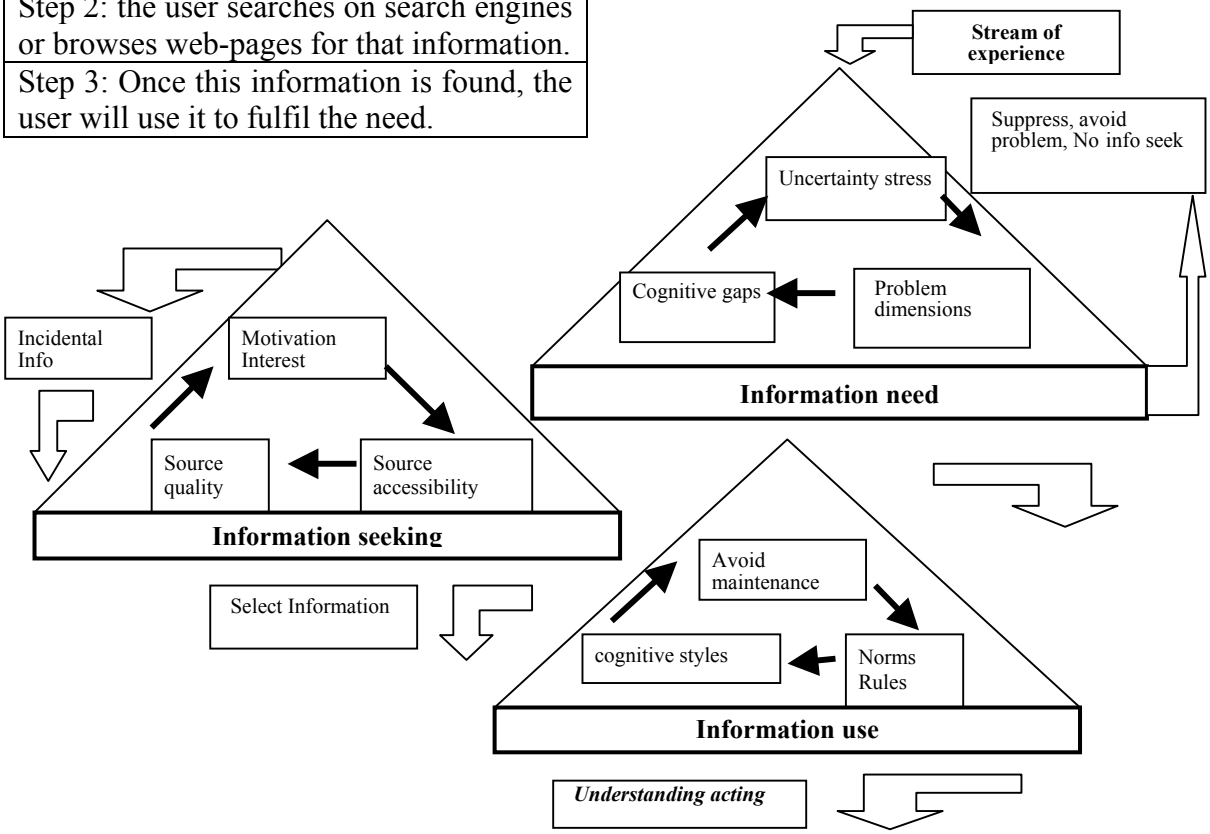

Figure 1: Choo's ISP Model

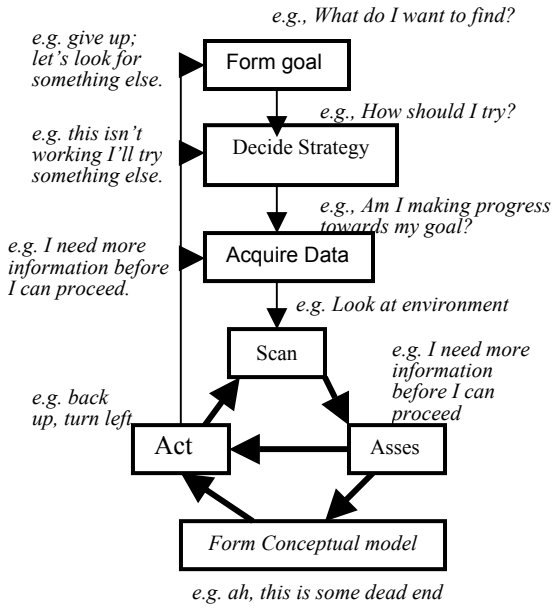

Figure 2: General framework for the navigation process, Spense/Furnas et al

Here we miss the behaviour model aspects during the *browse, assess* and *act* stages. We consider it clearer for web-design purposes to include in the model the steps before the user starts with search tasks. In this respect it is appealing to study the context of decision strategies, i.e., the user's decision processes about, e.g., how to perform the tasks, and when or under what conditions to stop or retry.

3.3 Ellis model

Ellis's model [4] includes a comprehensive set of steps for *browse, assess* and *act* stages (Figure 3):

1. *Survey*: identifying websites, web-pages with information that the user acquires to fulfil his need.
2. *Chain:* following links to content-related websites / web-pages.
3. *Monitor*: website updates, push agents, profiles, revisiting 'favourite' websites for new information.
4. *Browse*: scanning top-level pages for lists, book-marking, printing, copying, pasting.
5. *Filter*: choosing relevant information (criteria differ for individuals, goals).
6. *Extract*: systematic search for needed information.
7. *Verify*: checking validity.
8. *End*: info found/ other reasons.

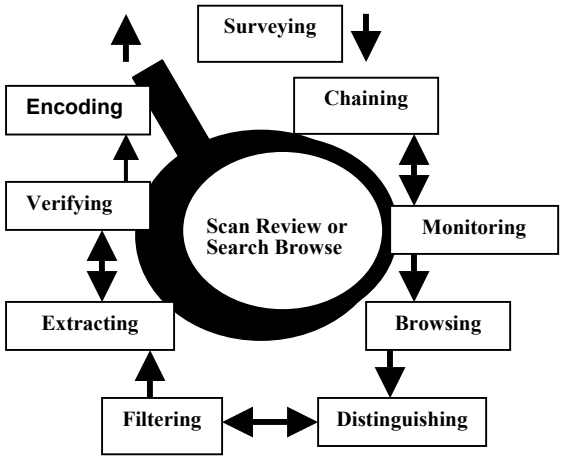

Figure 3: Ellis's navigation model

Here, we miss the stages from sensing a need to establishing tasks, but the other stages are very clear.

Unfortunately, these models give us no indication *why* users behave differently. Reasons can be different cognitive styles, background knowledge and general belief systems, which translate into different problem solving techniques. User modelling tries to track down these behaviouristic issues. Our studies of the above models have led us to adopt a model for our work, which includes and structures the features they introduce.

4 Our WWW ISP model

Our extended version of the information-seeking process model must be particularly suited to navigation on the WWW. We have identified three steps, by integrating the general information seeking model above with the needs model and the MAO model, as follows:

1. the user experiences an information need in the context of a/some
a. functional need(s) and/or b. symbolic need(s) and/or c. hedonistic need(s).
2. the user searches for information on the WWW
a. to find information about X. b. to find a way to enhance/change their self-image, public image or esteem. c. to have sensory pleasure.
3. the user uses the information found
a. to read, buy, compare, verify, exchange, or … X. b. to interact with others, copying others behaviour etc, c. to have pleasure.

Step one starts with a sensory or mental input that triggers the user's attention. If the user decides not to ignore it, then it will transform into an information need plus a functional, symbolic or hedonistic need of social or non-social nature.

When the user feels such need(s), s/he experiences an inner state of tension caused by a (perceived) distance from an ideal or desired physical or mental state. The user attempts to regain a sense of equilibrium by conceptualising some goal supported by task(s) in order to make their information needs clear and feasible and fulfil them.

During the second step, the user will seek information on the WWW. This typically consist of looking for texts, pictures,

videos, sounds, etc. for which the user performs WWW navigation or a keyword search, etc.

Step three starts when the user has completed the browsing and/or search task(s). In the ideal case, the user has found what s/he was looking for. Once accessed, the information can be used to satisfy the perceived need. For example, the user reads an article on health issues to stay well informed (information + functional needs), buys a bigger car to show off when meeting peers (information + symbolic needs) or tries a recipe for that delicious looking cake (information + hedonistic needs).

Given the role of the *perceived information need* (computable from the MAO model) in motivating the user, as shown with the help of the MAO model, this is very important in developing guidelines for new websites. Obviously, the user will become more motivated by websites where their need, goal and tasks are made clear and feasible. Moreover, the ability and opportunity requirements of the MAO model can be supported by the web designers, by a simple design with well supported options.

Depending on the intentions of the website designer(s), the extended ISP model can be used to achieve different goals. For instance, for commercial sites, where the goal is to sell (as much, and as often as possible), the client's need has to be triggered in order to revisit the site. For educational sites, revisiting might be not always desired, for instance when wanting to avoid site overload and to give the chance to new students to access the material. Therefore, sites should trigger an increased need to know, with pointers to other sites.

Our model is illustrated in Figure 4. This model attempts to provide the researcher at least with the possibility to describe the errors made by the user [16] by adding error modelling and to express MAO features.

It is important not only to design models, but to make them also computable. A pseudo-mathematical expression of our Internet navigation model is presented in the following.

1. prior knowledge(A) # A is the user's prior knowledge
2. ¬ know(X) # need of X
3. know(Y) → know(X) # knowing Y implies knowing X
4. X ⊆ Y # Y is a reformulation of X in context; this makes X searchable on the WWW
5. case 1: Y ⊆ A => END # if Y was contained in initial prior knowledge, X can be deducted, so no search is necessary
6. case 2: Y ⊄ A => SEARCH(Y, WWW) # search for Y on WWW
7. subgoal(Y) # Y becomes the next subgoal (if prior goal already exists)
8. select_strategy(Y) a. # a search strategy should be selected, e.g., search, browse, chaining, monitoring, etc.; or combination of the above b. quality criteria should be selected (i.e., how good the solution should be) c. quantitative criteria should be selected (i.e., how many solutions are needed) d. end (stop) criteria should be selected (timeout, number of steps, etc.)
9. run_search # this is the "aquire data" phase; search is performed conform with decision strategies
10. interpret_effect # here, the solution can be evaluated, diagnosed, error correction performed
11. use(X) # this is the information use stage
12. interpret_effect # here, the usage as well as the solution can be evaluated, diagnosed, error correction performed

The model still excludes the possibility to show why and in what way the different users behaved. This could be solved by building a MAO database and perform consistency checks, as well as cognitive styles checks.

Currently our studies concern the behaviour of the user as viewed from the user's own perspective. This means that we do not attempt to explain what the user is doing, but rather try to find out the drives of the user's behaviour and the triggers of user satisfaction. We have decided to start by building a user model that describes not only user attributes, like subject knowledge and system experience, but also gives an overview of the need, goal and tasks that the users pursue.

5. Discussion and Future Work

Our agenda has focused on four elements:

- the possible need, goals and tasks of the intended audience of the web application.
- the existing content: information and products as currently available.
-the way an author - and user persona are created on a web application.
- ways to help WWW user navigation, by using, e.g, Social Navigation [10].

We use information about possible needs, goals and tasks instead of deploying usage pattern data because at the moment it is still very difficult to get useful and correct information from user navigation patterns.

For different needs and goals, different types of information, and interaction with other visitors are necessary. Therefore it is important to first make a decision about what the target audience wants and then what the company, institute or individual can provide, to make the match.

To clarify the goal of a web application for visitors, we can deploy an author - (virtual person or voice on the web) and a user persona (role the actual user is asked to play). In this way users could tell if they are part of the target audience or not and what the web application [9] or Social Navigator [10,13] offers. Here it is important to consider design goals (attract users or filter unwanted users out).

Finally, we have to make a bridge between the users who have, both information and social need, and the development of appropriate web applications. The EOL technology-based grocery store is a good example of different ways to become aware and interact with others [10]. Also the Juggler system gives interesting suggestions about a web application based on social needs [9].

6. Conclusions

In this paper, we have described the WWW navigation and search process as sub-categories of a generalized ISP. We added relevant features and extend this model towards a better interpretation of WWW user behaviour. Moreover, we presented, discussed and criticized existing WWW ISP models, and integrated their features into a new model, with extended capabilities (e.g., diagnosis capability).

Finally, we discussed future directions of research, within the global state-of-the-art research framework.

The main focus of this paper is the integration of needs in the WWW ISP modelling, and concentrating on the user point of view in a User-Driven Internet.

References

1. Brusilovsky, P. *Methods and techniques of adaptive hypermedia.* UM & User adapted interaction Vol. 6, No. 2-3, 1996, 87-129.
2. Carmel, E., Crawford, S. and Chen, H. Browsing in hyperspace: A cognitive study, *IEEE Transitions on Systems, Man, and Cybernetics*, Vol. 22, No. 5, September/October 1992, 865-884.
3. Choo, C.W., Closing the cognitive gaps: How people process information, *Financial Times of London*, Information Management Series, March 22, 1999.
4. Choo, C. W., Detlor, B. and Turnbull, D. Information seeking on the Web: An integrated model of browsing and searching: http://www.firstmonday.dk/issues/issue5_2/choo/index.html
5. Coney, M. B. and Steehouder, M. F., Quicklist for designing personas. http://www.techcomm-online.org/shared/special_col/quicklists/personas.html
6. Coney, M. B. and Steehouder, M. F., Role playing on the Web: Guidelines for designing and evaluating personas online. *Technical Communication*, third quarter 2000, 327-340.
7. Cristea, A. and Okamoto, T., Considering automatic educational validation of computerized educational systems, *ICALT2001*, Madison, USA, 2001. http://wwwis.win.tue.nl/~alex/Conferences ICALT/ICALT.doc
8. De Troyer, O., Goedefroy, W. and Meersman, R., Using user classes and user requirements granularity to design websites, Tilburg University, 1998.
9. Dieberger, A., Supporting social navigation on the WWW, to appear in *International Journal of Human Computer Studies*, Special issue on innovative applications of the WWW, 2001.
10. Dieberger, A., Dourish, K., Höök, K., Resnick, P. and Wexelblat, A., Social navigation: Techniques for building more usable systems, 2001. http://www.sics.se/~kia/publications.html
11. Erickson, T. and Kellogg, W. A., Social Translucence: An approach to designing systems that support social processes. *ACM Transactions on HCI,* Vol. 7, No. 1, March 2000, 59-83.
12. Hoyer, W. D. and MacInns, D., *Consumer behaviour*, Houghton Mifflin Company, second edition, 2001.
13. Jul, S. and Furnas, G. W., *Navigation in electronic worlds: A CHI 97 workshop*. http://www.acm.org/sigchi/bulletin/1997.4/jul.html
14. Raghavan, P., Social Networks on the Web and in the Enterprise, Invited Talk, *Web Intelligence: Research and Development, First Asia-Pacific Conference, WI 2001*, Eds. N. Zhong et al., Springer, 2001, 58-60.
15. Spense, R. A framework for navigation, *International Journal of Human-Computer Studies*, 51, 1999, 919-945.
16. Sutcliffe, A., Ryan, M., Doubleday, A. and Springett, M. Model mismatch analysis: towards a deeper explanation of user's usability problems, *Behaviour & Info Technology*, Vol. 19, No. 1, 2000, 43-55.
17. Turk, A., A contigency approach to designing usability evaluation procedures for www sites, EnCkompass 2000, 2nd Workshop, September 2000.
18. Zeldman, J., Designing your audience, A list apart: for people who make websites, 1999-2001. http://www.alistapart.com/stories/who/index.html

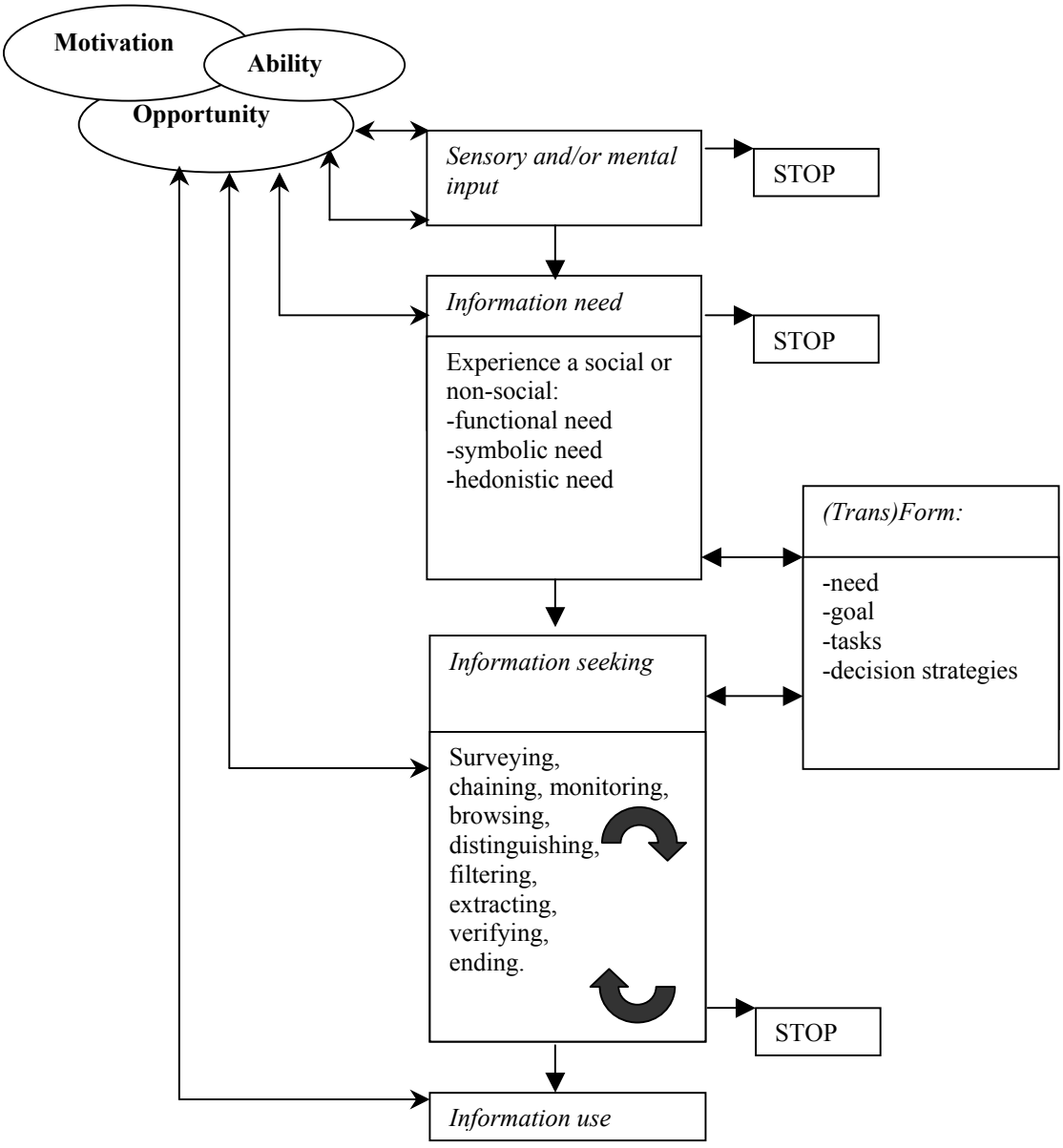

Figure 4: Our model of navigation on the Internet