Creating *SPIN*: Mutual Communication in Evaluation and Exhibits

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> "Our relationship was now clear to me. We were fellow searchers, companions, like spirits . . . Let's go and have a look, let's go and find out."
> --Fynn, *Mister God, This Is Anna*

SPIN, a traveling hands-on exhibit about rotational motion, was created by Impression 5 Science Museum for the Exhibit Research Collaborative. We wanted to design *SPIN* with an emphasis on communication *with* visitors rather than teaching at them. By changing our evaluation techniques we began to recognize different forms of communication and their impacts on visitors' involvement. Interviews helped us understand that mutual communication requires giving attention and respect to visitors' reactions, ideas, abilities, and interests. As we learned to see our work and visitors' worlds through their eyes, we were able to imagine ways of generating visitor-object and visitor-developer dialogues in the exhibit.

What Is Mutual Communication?

We initially planned to use only short interviews and extensive prototype observations during evaluation. Although our brief predict-explain interview provided valuable information for exhibit content, it was limited in its ability to adapt to a diverse range of visitor responses. Consequently, we began to supplement the short interview with an informal conversational interview. During these portions, visitors were able to engage in more open-ended speculation about the device, and/or discuss some of their general learning experiences. The evaluator probed by asking, "why, how, what if" questions and by offering acknowledgement and reassurance (e.g., "that's very interesting"; "your ideas are important to us"). We also allowed some visitors to continue discussing the device with their companions after the interview. Sixty-eight interviews were conducted and videotaped. All began with a short predict-explain interview, about half included the conversational portion, and one-quarter involved interactions between companions.

Altering our interview format produced dramatic changes in visitors' involvement. During the short interview we followed a very linear protocol and did little probing. Although visitors were usually pleasant, they were rarely impassioned. As the interview opened into a more conversational format, courteous acquiescence often transformed into excitement. Rather than just trying to recall facts or simply saying "I don't know," visitors were much more likely to initiate and "play" with creative explanations. They were eager to test their ideas by handling the device, making comparisons to familiar events, and trying to recall related information. This was accompanied by comments about their feelings toward science, school and learning. Because the interviewer did not give confirmation or additional information, the accuracy of visitors' nondescriptive explanations did not always increase during the informal conversation (it did not decrease). However, there were often obvious increases in a visitors' level of physical activity, accuracy of descriptions (observations), references to connections, and/or the number of speculative explanations and suggestions they gave.

Many educators have observed that student involvement increases when one-sided lectures are replaced with exploratory dialogue (e.g., Alpert, 1987; Bruner, 1979). Such exchanges help students develop an understanding of the meanings of concepts and relationships between concepts. As they articulate their own views, respond to others, and negotiate meanings, students can learn how to learn (Novak & Gowin, 1984). Inclusive dialogue provides a supportive and stimulating environment in which students discover themselves as active, capable participants in the construction of shared understanding (Belenky, et al, 1986). In these views, mutual communication is an integral aspect of discovery learning. Discovery through shared exploration is a marked contrast to traditional didactic settings in which students are passive recipients of existing information.

In mutual communication, all participants are simultaneously recipients and senders of verbal and nonverbal information. This type of dialogue is occurring in an interview when, "the interviewer provides a stimuli to generate a reaction. That reaction from the interviewee, however, is also a stimulus to which the interviewer responds. The flow of communication back and forth occurs in the context of the whole interaction" (Patton, 1988, p. 127). The interpretations people give to the information they offer and receive are shaped by their perceptual filters (Borun, 1990; McManus, 1988). To maintain mutual communication, people must continually negotiate meanings. Dialogue participants do this by closely attending to each other as they share and adapt their understanding. This is a transactional model of communication (Tubbs & Moss, 1987).

Mutual Communication in Exhibits

Exhibits which encourage discovery may be a way to tap visitors' intrinsic motivation and foster deep levels of involvement (Chambers,

1990). Mutual communication is exploratory, especially when information is used as a tool, or fuel for the dialogue, rather than an end in itself. Exchanging information helps participants affirm and reshape tentative ideas. In exhibit experiences, "information" can be both verbal and nonverbal (e.g., movement) and "participants" can be human or inanimate. Inanimate entities (e.g., objects and text) often serve as channels through which people communicate. Some objects can also dialogue directly with people by initiating and responding to nonverbal information. For example, when visitors use an interactive exhibit containing a model of an early Bell telephone, the device is both a channel which communicates information about Bell and his culture, and an object which communicates directly with visitors through its behavior.

In trying to imagine a transactional exchange involving objects, "it may be useful to think of a dialogue between a child and materials . . . At times no words may be involved at all . . . But there is surely some sense in which materials 'speak' to a user before, during, and after they are used. In some instances, the user's actions prompt a response" (Kallet, 1971, 1977). We wanted strong visitor-object dialogues in *SPIN*. Consequently, our primary guideline for devices was their ability to generate sensory information and respond to physical activity. This is different from having an object function as a symbol which communicates a developer's message (e.g., a papier mache planet designating a space travel exhibit). In that case, the object is a channel.

Similarly, images and words are symbols which can allow signage to serve as a communication channel. Paulette McManus describes this as a "conversational relationship between the label writer and the visitor" (1990, p. 126). She explains that visitors interact with signage as if it is talking to them; they also talk back at it. A mutual dialogue may be possible if the label writer (speaking through the signage) can acknowledge visitors' responses to them. This occurs in labels through both verbal and graphic information. Labels also express nonverbal information through factors like position and tone. These implicit messages can reflect developer's biases toward visitors (Shettel summarizing Gurian, 1988). By helping us attend to visitors' "voices," examine our attitudes, and practice new patterns of interaction, evaluation altered both the content and tone of the visitor-developer dialogues in *SPIN* signage.

Just as human conversations can involve more than one person, visitor-object and visitor-developer (via text) dialogues happen simultaneously during an exhibit experience. In addition, visitor-visitor dialogues are often taking place. Judy Diamond has examined the interactions between family members using exhibits. She explains that "this mutual exchange of information is an important aspect of the learning process" (1986, p. 153). Although we did not set out to generate this type of interaction in *SPIN*, it is interesting that it frequently and intensely appeared in the prototypes and final exhibit. This may be because one (or more) members of a social

group will often use the devices while another offers suggestions and explanations while reading labels. The fluid visitor-object and visitor-developer (via text) dialogues in *SPIN* may make it easier for companions to interact by offering a rich flow of activity and information.

Designing for Mutual Communication

SPIN incorporates both traditional and experimental design techniques. It contains common elements of standard content-driven exhibits in which technical information flows unidirectionally and is tied to specific educational objectives. However, we also tried to create more discovery-driven experiences in *SPIN* through mutual communication. The purpose of these interactions is not knowledge acquisition, but the personal involvement of visitors in exploration.

The specific techniques we used to generate visitor-object and visitor-developer dialogues in the exhibit can roughly be grouped into three overlapping categories: a) creating an inclusive setting; b) maintaining feedback; c) generating adaptability. These techniques are used throughout the eleven activities and accompanying signage. The devices are large, bright, low tech, and very interactive. The signage is made of multi-colored, poster-sized panels which use a visually active comic book format. Some of the techniques we tried are described below. (Signage excerpts are written in italics. Slashes represent sentences broken into text boxes.)

Creating an Inclusive Setting

Mutual communication requires that all participants must feel comfortable entering (and remaining) in the dialogue. In Elaine Heumann Gurian's keynote address to the 1990 Visitor Studies Conference, she advocated for a "dialogue of equals" in exhibits. We knew from our interviews that many visitors already feel alienated by science and traditional school settings. Allowing them to express these feelings seemed to make it easier for them to risk sharing their technical ideas. Our task was to make the exhibit environment safe and yet challenging enough for visitors to participate. These are some of the ways we tried to create an inclusive setting:

- The signage shows images of male and female visitors of diverse ages and racial backgrounds using the exhibit. We approach this in a playful manner, sometimes contradicting stereotypes. For example, an elderly woman sits on a spinning device, a businessman spins in his office chair.
- Visitors are not cast in a singular, fixed status. The "voices" in the signage express a broad range of visitor-developer roles. Sometimes the text functions as a parent or teacher, providing specific directions and explanations. When doing so, we use an informal "you voice"

rather than a depersonalized tone: *"Cup your hands around the top. / Feel the air being pulled outward and spun by the top."* (The Friction Story). Other times, "we" are a group of companions joining the visitor in playful exploration: *"What if you only use three weights?"/ "What about two?"* (Law of Torque).

- Equipment is demystified so it is accessible to visitors. The devices are very simple and their mechanisms are explained: *"Our gyroscope is made up of a spinning wheel mounted in a round frame. . . / an electric motor to keep it spinning. . . / . . .and a little weight for balance."* (Gyroscopes).
- Visitors' affective responses are acknowledged as a natural part of exploration. A range of emotions are expressed, such as: puzzlement/curiosity – *"Precession? Now what do you suppose that is?"* (Rotational Inertia); excitement – *"Oh! I get it!"* (The Friction Story); fear/hesitancy – *"Math! Oh no! Here comes the scary part!"*, and its resolution – *"Oh. That wasn't so scary."* (Law of Torque).

Maintaining Feedback

To keep the dialogue flowing back and forth, each participant must be able to generate clear, direct, and relevant information. They also must be able to respond to information they receive from the other participants. In addition, the pattern of the communication must be viable for all participants. For example, it must not bewilder visitors by using formal styles familiar only to scholars. Here are some ways we did this in *SPIN* (using the gyroscopes as a main example):

- *SPIN* devices are designed to "listen" to visitors by readily responding to their actions and to "talk" by giving immediate sensory feedback. For example, a visitor acts by gripping the handles of a hanging gyroscope and exploring it with general movements. The gyroscope responds by translating the visitor's motion in unexpected directions. The visitor can refine their hand movements to ask more specific nonverbal questions (e.g., "Which way will it go when I move left?"). The gyroscope responds with more specific information (e.g., it moves directly upward when the visitor goes directly to the left). Signage says, *"You apply a sideways force with your hands, but the gyroscope responds by moving upwards."* (Gyroscopes I. Text also addresses the specific responses.)
- Visitors' actions and senses are emphasized as important sources of information: *"What do you see?"* and *"What differences do you feel?"* is asked throughout the signage. Sometimes this approach required acknowledging necessary contradictions in the exhibit rather than ignoring visitors' observations of them. For example, one gyroscope helps visitors explore gyroscopic inertia by remaining stable as they move it through an arc. The signage explains that the axis keeps

pointing in the same direction. However, some visitors will notice a slight wobble in the device. We decided to address this by adding a conversation between two sets of "eyes" in the signage: "*Yeah, but it did move a little bit . . . /That's just precession, caused by friction from the bearings. / Huh? /Check out Part III.*" (from Gyroscopes II. Gyroscope III devices relate directly to precession.).

- Graphic illustrations relate technical terms to the actual movements of people and devices. For example, signage panels contain pictures of gyroscopes which look just like the device. They are shown in the hands of visitors, often from the viewpoint of their eyes. Arrows indicate the movements of the hands and the object. A big red arrow containing the words, "*This is called Precession.*", sweeps around one of the pictures and points to an explanation.
- Explanations are often formed around visitors' sensations rather than abstractions: "*When you push on the gyroscope you can feel it resist movement out of its plane. /Yeah, but it did move, it moved sideways. /That's because your finger is an outside force acting on the gyroscope . . .*" (Gyroscopes III).
- Text includes both familiar and unfamiliar terms. Everyday words, phrases, and even casual exclamations such as "*Yeah*" and *Oh no*!" are used throughout the labels. We tried to introduce new terms in ways that help visitors use them in spoken dialogue. "*That's pronounced TORK.*" (New Twist).
- The text dialogue is modeled around patterns of everyday conversation. *SPIN* signage often "talks" with visitors in the informal ways that they talk with each other. It asks questions, suggests activities, offers its "thoughts", and refers to everyday life: "*Try to balance as you walk on a log or curb.*" (Kiosk). Sometimes technical concepts are built around conversational metaphors: "*Math is just a language; it uses symbols to represent ideas.*" (Law of Torque).

Generating Adaptability

Mutual communication which is exploratory cannot be predetermined by one participant. The particular pathway which the exploration takes is influenced by all the participants and unfolds as they interact. The participants' ability to seek connections in the information they share (Kallet, 1971) helps provide an open-ended flexibility which does not dissolve into randomness. Some of the ways we tried to provide meaningful adaptability include:

- The flow of activity and information in the exhibit is arranged in a web-like manner. There are multiple, interconnected pathways throughout the exhibit. Each device relates physically and conceptually to a variety of other devices. For example, there are

four flywheel-related activities (timed flywheels, comparison flywheels, water pump, the tops). Three activities directly involve precession (Gyroscopes I, III, and the tops). The signage refers to the interconnections "*There's more to precession, ya know . . . try spinning a top*!" (Gyroscopes III), "*But where does the friction come from? / I don't think the story ends here.*" (Top Takes An Unexpected Turn).

- The design is nonlinear. The exhibit components can be used in any order. Visitors can read all the frames in a panel of signage or glance up and "grab" parts. Much of the text is written and presented in "pieces" (text boxes, "thought balloons", etc.). Often the content of a "piece" is written so that it can serve as both a whole concept and a part of a larger concept.
- Visitors have broad and ongoing options. The multiple pathways are not set up in a way that only give the option of choosing "Path A, B, or C" and then proceeding down a singular corridor. Visitors can move in a variety of directions at many points. No path between components requires taking or excluding another path (or backtracking). Visitors can choose their direction as they explore, responding to their thoughts and actions, the actions of a device, and whatever portions of signage they read. We also offer straight paths for visitors who want that type of structure (e.g., Gyros I, II, III). Whichever approach they take, visitors can use as many or as few of the components as they want.
- We included open-ended questions: "*So what do you think would happen if an astronaut tried to turn a wrench in space*?" (New Twist). Often information is offered as an exploratory tool, rather than an answer: "*Hint, hint. Winka, winka. / Use the math . . .*" (Law of Torque).

Making mutual communication central to *SPIN* dramatically affected both the overall thematic design of the exhibit, as well as the design of specific devices and labels. Initially, we had envisioned a carnival theme for the exhibit, with flashy trappings to "hook" visitors and games to hold them. However, visitors' intense participation in the conversational interviews made this seem unnecessary or even counterproductive for this exhibit. The mutual exploratory dialogues appeared to have an intrinsic appeal. They generated a genuine excitement which the "tricks" could only mimic. By the final design of *SPIN*, the carnival theme had fallen largely by the wayside. Instead, the devices and signage simply reflect the dynamic playfulness of communicators who are deeply engaged in exploration. The exuberance of the exhibit is a natural expression of that relationship.

Conclusion

In creating *SPIN*, we have just begun to explore mutual communication in evaluation and exhibits. We will try to expand our understanding of this approach during our next Exhibit Research Collaborative project, an exhibit (tentatively) called *Connecting with Chemistry*. This exhibit will focus on visitors' investigative processes as they explore broad chemistry concepts. To do this, we will need effective techniques for generating visitor involvement and discovery. Our next step is to develop a method of mapping the potential flow of communications which may occur during the exhibit experience. Assessing the information exchange between visitors, devices, and the developers (via text), may help us create an environment which encourages visitors' confidence and pleasure in interactive exploration. We hope that the intrinsic joy which marks the journeys of "fellow searchers" can become an apt description for our visitors' exhibit experiences.

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Notes

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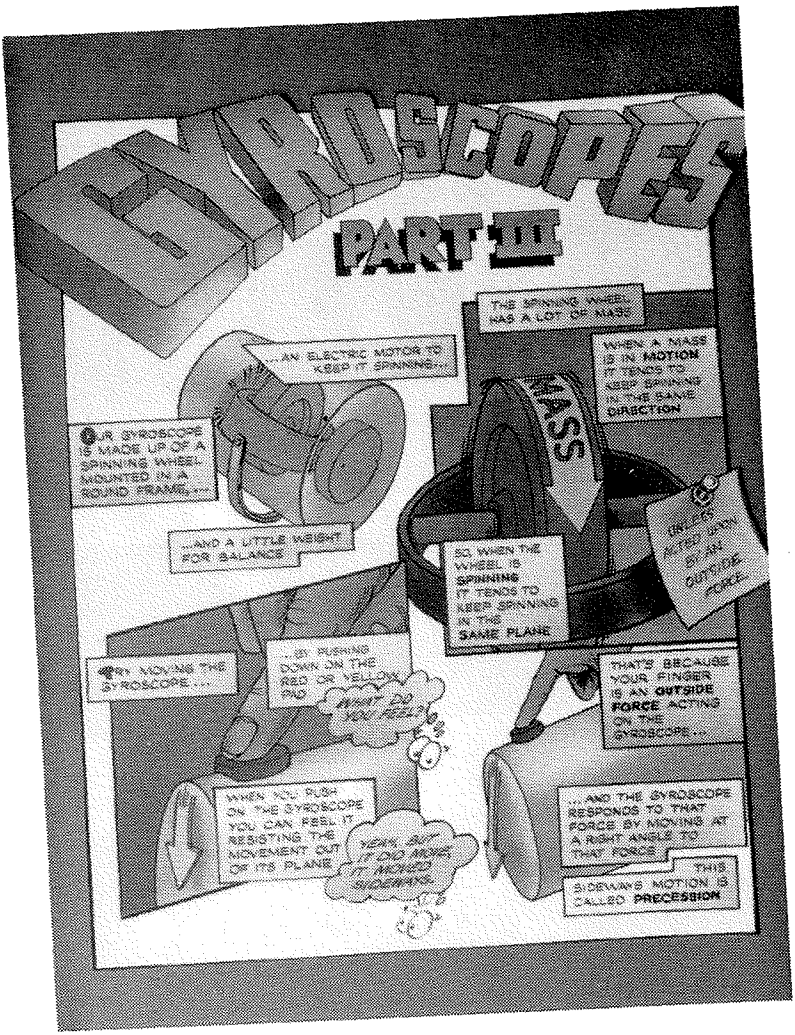
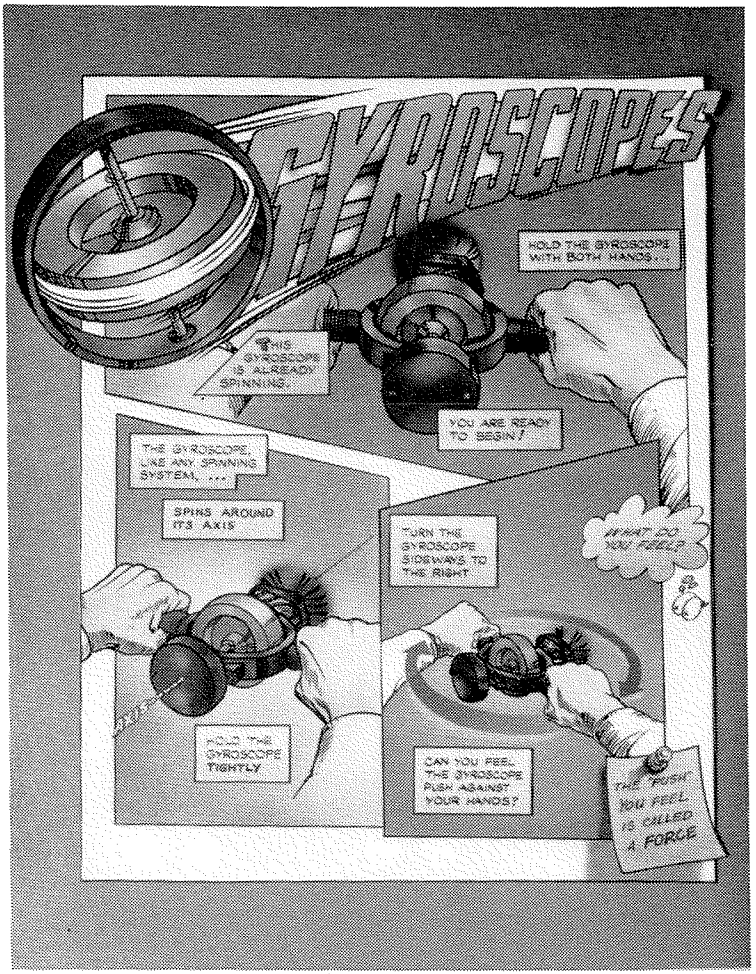
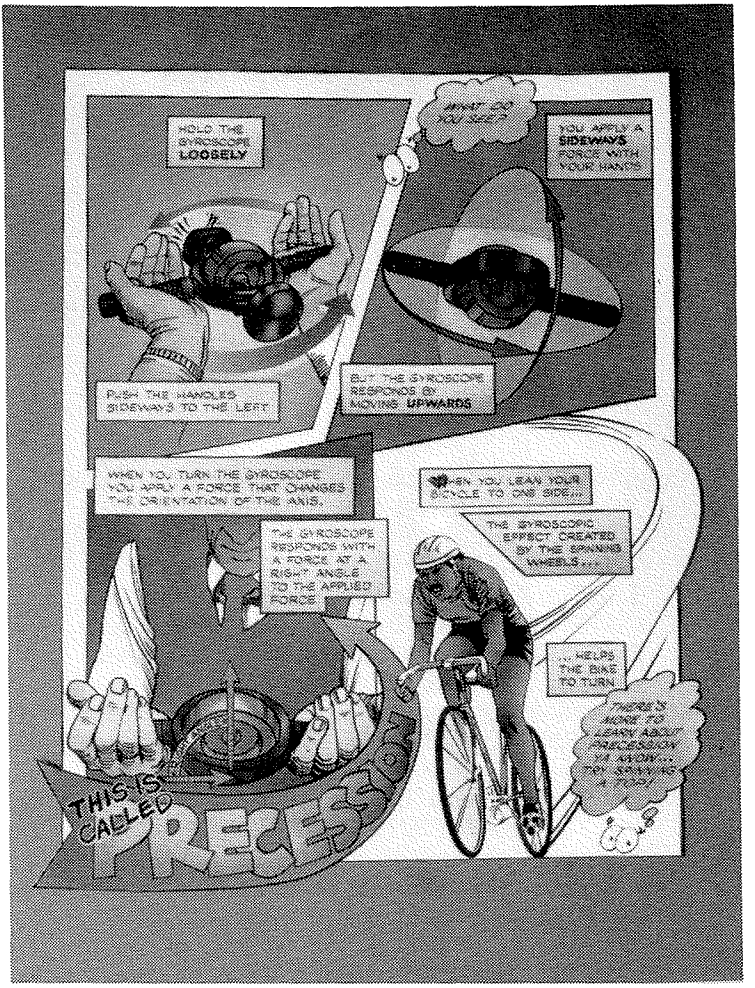
For a report summarizing the effects of evaluation on the specific technical content of *SPIN*, contact Patty VanLuven. For information on purchasing or renting *SPIN*, contact Impression 5 Science Museum.


GYROSCOPES
PART III
THE SPINNING WHEEL HAS A LOT OF MASS
...AN ELECTRIC MOTOR TO KEEP IT SPINNING...
WHEN A MASS IS IN MOTION IT TENDS TO KEEP MOVING IN THE SAME DIRECTION
OUR GYROSCOPE IS MADE UP OF A SPINNING WHEEL MOUNTED IN A ROUND FRAME...
MASS
...AND A LITTLE WEIGHT FOR BALANCE
SO, WHEN THE WHEEL IS SPINNING IT TENDS TO KEEP SPINNING IN THE SAME PLANE
UNLESS ACTED UPON BY AN OUTSIDE FORCE
...BY MOVING THE GYROSCOPE...
...BY PUSHING DOWN ON THE RED OR YELLOW PAD
WHAT DO YOU FEEL?
THAT'S BECAUSE YOUR FINGER IS AN OUTSIDE FORCE ACTING ON THE GYROSCOPE...
WHEN YOU PUSH ON THE GYROSCOPE YOU CAN FEEL IT RESISTING THE MOVEMENT OUT OF ITS PLANE
HOW ARE IF YOU MOVED IT MOVING SIDEWAYS?
...AND THE GYROSCOPE RESPONDS TO THAT FORCE BY MOVING AT A RIGHT ANGLE TO THAT FORCE
THIS SIDEWAYS MOTION IS CALLED PRECESSION


GYROSCOPES
HOLD THE GYROSCOPE WITH BOTH HANDS...
THIS GYROSCOPE IS ALREADY SPINNING.
YOU ARE READY TO BEGIN?
THE GYROSCOPE, LIKE ANY SPINNING SYSTEM, ...
SPINS AROUND ITS AXIS
TURN THE GYROSCOPE SIDEWAYS TO THE RIGHT
WHAT DO YOU FEEL?
HOLD THE GYROSCOPE TIGHTLY
CAN YOU FEEL THE GYROSCOPE PUSH AGAINST YOUR HANDS?
THE PUSH YOU FEEL IS CALLED A FORCE


HOLD THE GYROSCOPE LOOSELY
WHAT DO YOU SEE?
YOU APPLY A SIDEWAYS FORCE WITH YOUR HANDS
PUSH THE HANDLES SIDEWAYS TO THE LEFT
BUT THE GYROSCOPE RESPONDS BY MOVING UPWARDS
WHEN YOU TURN THE GYROSCOPE YOU APPLY A FORCE THAT CHANGES THE ORIENTATION OF THE AXIS.
THE GYROSCOPE RESPONDS WITH A FORCE AT A RIGHT ANGLE TO THE APPLIED FORCE
WHEN YOU LEAN YOUR BICYCLE TO ONE SIDE...
THE GYROSCOPIC EFFECT CREATED BY THE SPINNING WHEELS...
...HELPS THE BIKE TO TURN
THERE'S MORE TO LEARN ABOUT PRECESSION IN HOW... THE SPINNING WHEEL
THIS IS CALLED PRECESSION