

# Arousal

The concept of arousal has been a major aspect of many learning theories and is closely related to other important concepts such as anxiety, attention, and motivation.

One of the most important findings with respect to arousal is the so-called Yerkes-Dodson law which predicts a U-shaped function between arousal (motivation) and performance. Across a broad range of experimental settings, it has been shown that both low and high levels of arousal produce minimum performance whereas a moderate level of arousal results in maximum performance in a task. This suggests that too little or too much stimulation tends to be ignored by individuals.

Berlyne (1960) attempted to explain the relationship between arousal and curiosity based upon [Hull's drive reduction theory](#). According to Berlyne, there is an optimal level of arousal for an individual at a given time. If the level of arousal drops below the optimal level, the organism will seek stimulation (i.e., exploratory behavior). Berlyne argued that curiosity was a consequence of "conceptual conflict" that could be caused by: doubt, perplexity, contradiction, incongruity, or irrelevance.

Eysenck (1982) examines the relationship between attention and arousal. He concludes that there are two types of arousal: a passive and general system that can raise or lower the overall level of attention, and a specific, compensatory system that allows attention to be focused on certain task or environmental stimuli. Mandler (1984) argues that arousal is the key element in triggering emotional behavior.

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## ***Curiosity and Exploration***

By Susan Edelman  
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What makes people curious? Why do individuals explore the unknown? The research in these areas is inconclusive and often contradictory. Are curiosity and exploration motivations or drives? Can curiosity and exploration be operationally defined independent of one another? Motivation is defined as the arousal, direction and persistence of behavior (Franken, 1994); an internal state or condition that activates behavior and gives it direction; desire or want, that energizes and directs goal-oriented behavior; the influence of needs and desires on the intensity and direction of behavior. Drive is defined as a basic or instinctive need; a vigorous effort toward a goal; to cause and guide the movement.

Curiosity is defined as a need, thirst or desire for knowledge. The concept of curiosity is central to motivation. The term can be used as both a description of a specific behavior as well as a hypothetical construct to explain the same behavior. Berlyne (1960) believes that curiosity is a motivational prerequisite for exploratory behavior. The term curiosity is used both as a description of a specific behavior as well as a hypothetical construct to explain the same behavior. Exploration refers to all activities concerned with gathering information about the environment. This leads to the conflict and question of whether exploratory behavior should be defined in terms of the movements that an animal or human performs while exploring or in terms of the goal or purpose of the behavior observed. A clear distinction between these two may not always be possible.

What exactly are curiosity and exploration? Loewenstein (1994) points out four central issues of curiosity: definition and dimensionally, cause, voluntary exposure to curiosity, and situational determinants. He adds a fifth issue of superficiality and intensity since he states that curiosity can arise, change focus or end abruptly. Loewenstein believes that despite its transience, curiosity can be a powerful motivational force. "Curiosity often produces impulse behavior and attempts at self control" (Loewenstein, 1994). Just look at the stories of Pandora and Eve, in which curiosity causes people to expose themselves knowingly to terrible consequences. Langevin (1971) has conducted research in the area of curiosity and classifies measures of curiosity into two categories. First, curiosity is viewed as a motivational state and measured with behavioral indices. Second, he conceptualizes curiosity as a personality trait that is assessed by personality measures. It has been suggested that curiosity is not a unitary construct. At the conceptual level there are numerous definitions of curiosity which tend to encompass a broad range of

characteristics. For Fowler (1965), boredom is one prerequisite or motivation for curiosity (exploration).

Curiosity and exploration are difficult to define independently when looking at them from a psychological perspective, the concepts motivation and drive come into play and become intertwined. The underlying problem in using and defining (scientifically and socially) is the circularity of the terms.

Roget's Thesaurus says that the absence of curiosity is boredom, ennui, satiety, take no interest, mind one's own business, uninquisitive.

## **Historical Overview of Curiosity & Exploration**

The earliest discussions of curiosity were conducted by philosophers and religious thinkers and centered on the question of curiosity's moral status rather than on its psychological underpinnings. Cicero referred to curiosity as a "passion for learning" and argued that the story of Ulysses and the Sirens was really a parable about curiosity. Several forms of curiosity related behavior such as search behavior, movement toward an unknown object and asking questions are included in the area of motivational psychology, however, curiosity does not fit well into the conceptual framework developed along the traditional pathways of behavioral sciences. Firstly, the conception of an intrinsically motivated behavioral system, which cannot be linked to a reducible drive raises serious questions about motivational psychology since the 1950's. The idea of curiosity was rediscovered when laboratory researchers wondered about the maze activities of the lab rat when none of the drive states such as thirst or hunger were aroused. Secondly, Wohlwill (1981) states that the curiosity phenomena cannot be investigated without reference to the natural environment of an individual. Before 1950 curiosity was seen in the light of its social function, for example: the eagerness or greed to get to know something new for the sake of newness, and in early psychological literature the term curiosity had a negative connotation. The scientific term "curiosity" is more neutral.

The most basic problem that has occupied curiosity researchers and theorists is the underlying cause of curiosity. Is curiosity a primary or secondary drive? A primary drive is inborn or innate whereas a secondary drive is learned or acquired. The research is inconclusive. If secondary, from what more basic drive or motive does it derive? Older theories oriented toward instinct and drive concepts. The defining feature is that curiosity produces an unpleasant sensation (usually labeled arousal) that is reduced by exploratory behavior.

William James (1890) pointed out two kinds of curiosity. He emphasized the biological function of curiosity as a mechanism of instinct driven behavior that serves in approaching new objects. Approach and exploration are described as being characteristic forms of behavior. The second kind of curiosity pointed out by James is "scientific curiosity" and "metaphysical wonder" with which "the practical instinctive root has probably nothing to do" rather "the philosophical brain responds to an inconsistency or a gap in its knowledge".

In the psychoanalytical literature Freud views curiosity as a derivative of the sex drive. The partial impulse of looking motivates the child's great interest in all things and all events that have to do with sexuality. Whereas the looking impulse and curiosity are primarily sexual in origin, the child's exploratory interest and desire for knowledge can be considered to be a by product of cognitive development. Due to social pressure, sexual exploration is later abandoned.

Blarer (1951) states that the inhibition of curiosity may result in different forms of pathological behavior, such as depression, and higher levels of sensation-seeking or thrill seeking behavior. Blarer proposed curiosity to be intrinsic to the individuals perceptions and world experiences and thus Blarer is the basis for the intrinsic motivation viewpoint in curiosity theory.

## **Theoretical Conceptions of Curiosity & Exploration**

The postulation of an independent exploratory drive is based on the observation of the exploratory activities of animals in situations where there were no external stimuli to satisfy homeostatic drives (water or food). Nissen (1930) experimented with rats and defines exploratory behavior in two ways 1. as an inborn exploratory drive 2. that curiosity is a secondary or learned drive acquired through classical conditioning. Originally, Berlyne (1954a, 1960) thought that the aversive and drive-reducing effect of deviations of the arousal potential from the individual's optimum level as the underlying mechanism of curiosity. Since then, Berlyne has come to believe that curiosity is externally stimulated, and that the curiosity drive is aroused by external stimuli specifically stimulus conflict. This encompasses complexity, novelty and surprise. Berlyne believed that in the short term, stimulus change and novelty is accompanied by physiological change. However, over longer periods of time, investigating behaviors are not accompanied by readily identifiable physiological changes. Berlyne also holds that exploratory behavior serves to maintain or attain a medium to optimal activation level for the organism. In all cases where exploration takes place, arousal or desire is reduced.

Fiske and Maddi (1961) hold a medium arousal level model and differentiate between the terms arousal and activation. They define arousal as "diverse manifestations of activation, such as muscle tone, heart rate, and increased sensitivity for stimuli". Their definition of activation is "the state of a catalytic and energizing mechanism in the central nervous system".

McReynolds bases his theories of exploratory behavior on animal experiments. Motivational aspects of exploratory behavior, for example: a living being is active in order to receive new perceptual information from its environment, as well as adaptive aspects, for example: a living being is in a situation of stimuli that it must regulate and adapt to. Fowler's (1965) boredom-based perspective interprets curiosity as a homeostatic drive (internally stimulated) since the curiosity drive seems to be both evoked and satisfied by the same stimuli. He attacked Berlyne by noting the inherent contradiction in the view that the curiosity drive was both evoked and satisfied by the same stimuli. Theorists that believe that curiosity is externally stimulated were "forced to ascribe both

drive-eliciting and reinforcing properties to the same stimuli- namely the novel stimuli for which the animal responded" (Fowler, 1965). Fowler observed animals producing the exploration- initiating response before, rather than after, exposure to the stimulus.

Hunt (1963) states that curiosity refers to a "motivation inherent in information processing" this means that curiosity is a mixture of cognition and motivation. The main principle, which is equally as important as the drive reduction hypothesis is the establishment and maintenance of an optimal amount of incongruence. Incongruence determines the strength, direction and affective qualities of behavior.

## **Drive Theories**

Drive theories differ on whether they view curiosity as a primary or secondary drive. Some research has shown that unsatisfied curiosity tends to intensify over some interval as do other drives such as hunger and thirst.

Curiosity has a motivated force that is stimulated internally (boredom) or by external stimuli. However, Hebb (1955) believes that curiosity seeking behavior poses a paradox for drive based accounts of curiosity. "Drive is not simply a state the decrease of which is rewarding. At high levels the reduction of drive is rewarding, but at low levels, an increase may be rewarding" (Hebb, 1955).

What is the role of homeostatic drives to curiosity? Harlow states that exploration is an example of human motivation that is independent from homeostatic drives. Harlow's nonhomeostatic intrinsic drive theory has been attacked by drive and learning theorists. Kreitler and Kreitler (1976) have changed positions from the basic assumption of drive theory to a more cognitive process in the development of exploratory behavior.

## **Curiosity & Culture**

There is evidence for cross-cultural similarities in exploratory behavior (Dragun, 1981). However, cultures generally vary both in attitudes towards exploration and information seeking as well as in the range of situations allowing the expression of the various manifestations of exploration and curiosity, this is especially true for the sensation-seeking motive. Zuckerman (1994) defines sensation seeking as "the seeking of varied, novel, complex and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experiences."

Berlyne also conducted research on cross cultural comparisons in the area of curiosity. His findings conclude that there is a high similarity of demand characteristics of stimuli in two cultures of widely differing historical antecedents and technological development. Also, different cultures from various geographical regions show evidence for cross-cultural similarities in exploratory behavior. More research is needed to study curiosity behavior in its own cultural context to gain a better understanding of the functional relationships between various environmental and social facilitators and inhibitors of curiosity in a given society.

## Some Thoughts

There are varying points of view when it comes to theoretically conceptualizing curiosity and exploration. Research findings seem to be dependent on the theoretical orientation of the theorist and the emphasis lies on internal or external stimulus conditions, primary-inborn or secondary-acquired drives, and homeostatic-biogenetic versus nonhomeostatic-psychological motivations.

This is a difficult topic to conceptualize because of the circular nature of the terms and the contradiction and inconclusiveness of the research. Curiosity, exploration, motivation and drive are defined, described, explained and operationally defined in terms of one another, and thus become embedded and intertwined.

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## World Wide Web Resources

The following sites are both for information and just for fun!

- [Taking ADvantage - Curiosity Killed the Cat](#): Curiosity and Advertising.
  - [The Motive of Scientists.](#)
  - [Would Darwin Weep?](#)
  - [Nature of Science.](#)
  - [The Unified Psychology of Sensation Seeking.](#)
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## ***Curiosity and Exploration***

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The motive to explore the environment is presumably an evolved behavior that enables man and animals to gain information about an object or environment in the interest of survival. Many questions arise; why is curiosity maintained in a known environment? What determines individual differences in intensity of curiosity? Are people that score higher in curiosity measures more adapted? Can curiosity be taught by an aware caregiver? Are there downsides of curiosity and exploratory behavior? These questions will be addressed, not by a specific branch of psychology, but by the core of curiosity/exploration research which is subsumed by an eclectic theoretical framework.

### **Types of Explorative Behavior**

The first distinction to make is intrinsic vs. extrinsic exploration. Intrinsic explorative behavior is performed for its own sake, independent of external reinforcement (Condry, 1977). Activities such as play, spontaneous activity, imaginative behavior (and other comparable activities) are thought of as intrinsic because it's difficult (or impossible) to subsume them into a general principle of survival (Keller, 1987). In an experiment by Butler and Harlow (1954), monkeys confined in a dimly lit box learned to perform a simple task in order to open a window that allowed them to view the outside world. In a similar experiment, they quickly learned to solve a mechanical puzzle made up of interlocking pins, hooks and hasps. In both of these situations, no external reward was offered for exploration. Extrinsic explorative behavior is performed in order to receive an external reinforcement that is attainable only through that behavior. For example, at a job interview I may show great curiosity in question asking about the company and interviewer but in fact just be motivated by the task of getting the job.

Berlyne, the leader on exploration research has two further conceptual distinctions of exploratory behavior.

1. Inspective behavior, which is aimed at uncertainty reduction. An animal placed in a novel environment is likely to display this behavior in order to analyze the new situation, and to gain comfort by assessing escape routes, danger levels, etc.



2. Diverive behavior, which is stimulus/sensation seeking. An individual engages in this in order to relieve boredom or to raise arousal. Wohlwill (1981) adds a third type of exploratory behavior.
3. Affective exploration, which is directed at maintenance of an optimal hedonic tone. In children this may be high level play for the pure joy of it. In adults it may take the form of mental explorations, such as philosophizing. The difference between affective and diverive exploration can be thought of as different levels of the same thing. Whereas diverive behavior is aimed at boredom relief, or simple stimulation, affective behavior is more on the side of extraordinary stimulation. Although none of these behaviors are thought to be 'better' than the others, they do tend to occur in this order; that is, one is most likely to perform inspective behavior before diverive, and diverive before affective.

The emotional motivation for exploration: Many researchers see fear as the primary motivation; to reduce uncertainty. It is possible that this applies to the basic levels of exploration (inspective behavior). Diverive, followed by affective exploration may be driven by joy; the joy/comfort of mastery over one's environment. It should be noted however that excessive fear in the inspective stage can result in avoidance behavior -- which will be looked at further below.

Affective exploration is most often described as play or flow experiences. Bruner (1974) describes five key advantages to play:

1. Play results in a reduction in the seriousness of the consequences of errors and setbacks.
2. It is characterized by a very loose linkage between means and ends, allowing frequent opportunities to try combinations of skills that would hardly be tried under functional pressure.
3. There is an underlying scenario in which children create a rich and idealized imitation of life.
4. Children use play to transform the external world according to their own perceptions.
5. Play can function as a problem solving situation that then serves as a source of pleasure when solutions are discovered.

It's important to keep in mind that play/flow experiences are done for intrinsic reasons. Playing piano for example could be intrinsic if you really are playing for the 'good feeling' of it; it could also be extrinsic -- for example, when you are practicing for a recital. It should further be noted that play is not restricted only to children. For adults the primary use of play is 'I' above, which serves more as a letting go experience similar to laughter. It seems reasonable to consider this hedonic type of exploration as a sort of mental cooling down system. The lives of both children and adults can be extremely stressful and taxing, play and flow experiences (as well as laughter) often result in a feeling of great relief. The need for this type of experience is more pronounced in today's modern world as opposed to the pre-industrial world.

## Explanations for Explorative Behaviors

Voss (p. 46) defines curiosity as "a motivational tendency to reduce subjective uncertainty by generating meaning." According to Berlyne (1960), exploratory behavior is instigated by 'collative variables' of physical and mental objects, like novelty, ambiguity, complexity, and the objective uncertainty created by such objects in the subject. Accordingly, the exploration process involves three sequential steps. Notice that these three process relate to the three distinctions of explorative behavior above; the above distinctions can be thought of as the behavior classifications whereas the following steps are the motivations for the behaviors.

1. Uncertainty reduction. The individual explores the object or environment to size up the basic properties. A child picking up a lighter for the first time will touch it, and examine it carefully.
2. Incorporation. The individual determines the object's use. A child may discover that the lighter can produce a flame, or that it can be used to crush spiders (or something comparable).
3. Play/higher incorporation. The individual creates a reality with the object. The lighter may become a space ship that the child runs around with blowing things up; or less fortunately, burning things up.

Researchers claim that the higher level of incorporation is useful in adaptation in that individuals may use objects/environments to their advantage to a greater degree. This level of exploration is thought to exist only in the higher animals (it's not seen, for example, in reptiles). The spinner dolphins, which swim in large groups, display play patterns that also show an adaptive source. While the group swims close together, half of the pack breaks off and pretends to attack the other half, while the second half plays out the defense procedures. It is thought that this is a shark defense drill, since these dolphins (that are quite small) have to protect each other in groups against the shark threat. This activity may have some hedonic value (excitement/arousal of the play) as well as the adaptive purpose of anti-shark training.

Piaget refers to the exploring process in children as an 'active experimentation', or in terms of the attempt to overcome the resistance of the object. We may also think of this process as the generation and testing of hypothesis concerning the object's meaning and potential use (Voss, p.46).

Adult attachment style (Bowlby, 1973) may provide clues to individual differences in the information search. Secure infants, who use the caregiver as a secure base can feel safe to explore the environment, and will balance exploration and proximity seeking with the caregiver. Insecure (avoidant) infants on the other hand have trouble exploring since the caregiver's availability is doubted. Mikulincer, 1997 and others have found attachment style to make a difference in both exploration attitudes and behavior.

Mood is another determinate of exploratory behavior. Shillito (1963) believes that a kind of exploratory mood is necessary. Berlyne (1971) states that "Sadness, depression or

frustration, from which resignation and apathy result, make an individual more or less unable to react to external stimulation and thus keep him from engaging in exploratory behavior." Also, feelings of alienation have inhibiting effects on exploratory behavior as well as locus of control and learned helplessness. More on this will be discussed in 'How a curious mind is formed' below.

There are also some findings of sex differences in explorative behavior. Boys often explore more, and do more dangerous exploring. Maslow (1968) remarks further on how society tends to rear women with less enthusiasm for curiosity. "Many brilliant women are caught up in the problem of making an unconscious identification between intelligence and masculinity. To probe, to search, to be curious, to discover, all of these she may feel as defeminizing. Many cultures and many religions have kept women from knowing and studying."

## **The Basic Physiology of Curiosity**

The reticular arousal system (RAS) is believed to have the most to do with alertness or intensity of attention (and thus curiosity). It is a column of nerve cells extending through the lower brain. "The reticular formation receives sensory information by means of various pathways and projects axons to the cerebral cortex, thalamus, and spinal cord (Carlson, 1996)." When the RAS is injured, lethargy is apt to result. Its activation on the other hand gives rise to the arousal pattern -- alpha waves are replaced by faster, more irregular EEG activity. During exploration activities, heavy RAS activity is present. Activation of the RAS has also been associated with heightened sensitivity of the eyes, and it's been shown to increase an organisms ability to discriminate between objects more reliably and faster (Fuster, 1957).

## **The Effects of Exploring/Not-Exploring**

The effects of curiosity were marked even back to the late nineteenth century. William Small (1899) notes on the observations of healthy rats that "After the eyes and ears open instinctive activities, huddling, play, affective states and curiosity develop." Dooley (1921) also noted about the negative impact on curiosity of poor care giving. "...as a result of their mothers' failure to meet their needs at the critical time. Curiosity, doubt and fear... arose early and resulted in incomplete knowledge gained in a clandestine manner."

Are there negative effects of high curiosity? Several studies have shown that curiosity is a primary motive for dangerous activities and drug use. Most studies however show that curiosity is a positive trait. For example, a positive relationship between curiosity and creativity has been found (Vidler, 1977). Curiosity has also been identified as a major motivation for great accomplishments. For example, Robert Hoffman (1998) reports that intellectual curiosity is the highest rated motivating factor in doctors since the 1920's. Curiosity in general is identified as a positive trait, that predicts adjustment and success. It's also a reproductive trait, one that is looked for in a mate.

Exploration and curiosity have typically been thought of as positive factors enhancing the child's development that should be encouraged. These behaviors expose the child to information about the world and enlarge his/her knowledge. A study by Hutt and Bhavnani (1972) showed that boys (but with no significant findings for girls) responsiveness to novel stimuli in preschool years was associated with higher scores on a creativity test at age nine. Curiosity declines with age (correlation is about  $-.267$ ), because there is less uncertainty in the adult's world that needs to be understood. Swan and Carmelli (1996) show that participants (average age 70.6) that are high in curiosity have a lower rate of mortality. This doesn't mean that curiosity itself causes people to live longer, but it is correlated with factors that do. Some researchers see curiosity as a part of the larger construct of autonomy that is so important for older adults' survival.

## **How a Curious Mind is Formed**

How does one become curious? Saxe and Stollak (1971) found support for their social learning theory that both parental reinforcement and modeling foster children's curiosity and exploration. Endsley, Hutcherson, Garner and Martin (1979) observed mothers and their children in a play situation. They found first of all that boys and girls explored novel materials equally often; however girls asked about twice as many questions. Girls' mothers interacted more with their daughters than their boys. Most importantly, the frequencies with which the mothers showed exploratory behavior, curiosity orienting behavior, and question answering were all correlated with children's exploration and questions about the stimuli.

What happens when the child's attempt to explore is thwarted, say by a restrictive caregiver? What if exploration is met with negativity? What effects does parental authoritarianism/negative reinforcement toward curiosity have on a child? Since the first stage of exploration is designed at uncertainty removal, a child is vulnerable to succumb to fear and withdraw rather than exploration. When an individual ceases exploration due to either his/her inability to reduce uncertainty or by being stopped by outside forces (especially the caregiver) unpleasant feelings result, maybe a shift to anger or withdrawal. Exploration may begin again after a regeneration of the drive. Repeated experiences of failure in this process may lead to an external locus of control, feelings of helplessness, fear of failure and many other potential problems of development.

Hunter, Ross and Ames (1982) show that one year old children who were not allowed to finish a habituation to an array of novel stimuli then preferred a familiar stimulus and children who underwent full habituation to a novel stimulus then showed the tendency to select a novel object. The children who learn that they can explore successfully want to continue to explore whereas children who are thwarted are hesitant to explore novel stimuli.

It has been found also that the more unstable the self esteem the lower the curiosity of an individual. Keller (1987) found that "...anxiety or fear are manifested in withdrawal or avoidance behavior; by contrast, curiosity or exploration are indicated by the occurrence of approach behavior." In a case study of Paulette, by Alice Colonna (1996) she too

noticed the lack of curiosity/self-esteem link. Paulette's mother often reacted negatively (especially with stopping behavior) to Paulette's impulses to explore and as a result Paulette suffered from low self-esteem. In a later follow up, Pauletta was severely not persistent in her curious drives.

## Conclusions

Parker (1976) states that "As learned behavior becomes more important phylogenetically, curiosity and exploration play larger roles in adaptation." Parker is commenting on the altered state of natural selection. The factors that determined survival in the past apply differently in today's world of rapid growth. The ability to explore proficiently is an increasingly important trait. The need to develop well adjusted individuals is also increasingly difficult due to the complexity of the world.

It is helpful to imagine children as bundles of curiosity; it is their instinct, desire and their advantage to understand the world around them. We should be aware of the importance of developing explorative minds, and adjust accordingly to encourage them for not only the effect on society(e.g. a better adapted population) but to an individual's enjoyment and competence. It's important to know that we all loose curiosity of varying degree with age; and this happens largely because of a learned fear of knowledge. As Maslow (1968) states, "fear of knowledge... is a protection of our self-esteem, of our love and respect for ourselves." If we can learn a love for knowledge, we can grow and learn to love ourselves; and with courage, to love and master our environments. Parents should be shown the positive effects of supporting their children's curiosity and how to best do so. School curriculums can first focus on teaching an intrinsic desire to know before feeding kids facts and knowledge.

## Web Links

### [Curiosity and Exploration](#)

From the Web site Robyns Nest. Gives parents advice on how to deal with kids' curiosity.

### [Effects of Curiosity on Socialization-Related Learning](#)

Abstract of a dissertation by Thomas Reio Jr.

### [Curiosity and the Andragogical Model](#)

An article by Thomas Reio Jr.

### [Curiosity vs. Curriculum](#)

Advice for teachers for improving classroom learning.

### [Curiosity, Creativity, and Technology in Education](#) by Bob Avant.

An article written for an education course taught by Dr. Paul Resta and Dr. Tom Burnett, *Current Issues in Technology*.

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