

Beverage Informatics

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ABSTRACT

This paper explores the possibilities in general of using taste as a medium for data transmission and specifically of the creation of the News Brews system which uses coffee as a medium for transmitting news.

Keywords

beverage, coffee, data display, encoding, gustatory, informatics, networked object, news, news feed, olfaction, taste encoding

INTRODUCTION

For some time our lab has been concerned primarily with the display of data in absurd forms. Starting with the Doodlesnake project, which visualized drawn lines via a writhing 4 foot long serpentine sculpture, these displays began to take on qualities which were visceral and absurd, visualizing data in unconventional and often satirical ways.

The introduction of embedded internet devices into these displays in 2005 opened new avenues for accessing data sets to be displayed. The Chertoff project, though very simple, served as a proof that internet data could be easily accessed with minimal circuitry and displayed in a meaningful manner. Intended to address the meaninglessness of the Terror Alert Level system which had been introduced by the newly formed Department of Homeland Security(DHS), Chertoff consisted of a cutout of the head of Michael Chertoff(the chairman of the DHS) whose eyes were continuously updated to glow the color of the current terror alert level. This concept of live news display was further incorporated and refined in the Media Dialectics Titleflight project, which consisted of a pair of Rock 'Em Sock 'Em Robots which staged a fight in response to the frequency of keywords parsed from the New York Times website. Both of these projects represented the display of realtime data gathered from the outside world in novel and humorous ways. They also represented a first attempt at the incorporation of recognized icons(Michael Chertoff was on his way to becoming an iconic figure representing America's new police state and Rock 'em Sock 'em Robots are familiar pieces of the childhood of many Americans who grew up in the sixties seventies or eighties) into these data displays.

An attempt to make the display devices effective on a more visceral level led to the Interactive Thermal Proboscis- a giant wall-mounted copper nose with a surface temperature regulated to be the same as the outside temperature. The concept behind this object was the basic premise that since we sense heat and cold via touch, the representation of temperature in visual form(standard thermometer) is inefficient. The replacement, which gives users a sense of the temperature outside when they rub their noses against it is practical in the sense that it represents the temperature in a more concrete and relevant way than the thermometer while being presented in a playful and preposterous manner. Through this combination of utility and absurdity, a new joy is added to the attainment of the data. This act of adding magic to the mundane through careful deployment of what can be considered, for lack of a better term, silliness is a primary concern of this laboratory.

Yet our endeavors stretch beyond absurdity. For absurdity is merely an aesthetic choice. The main function of these devices is to endow the data that they present with personality and context. Data can be sterile and faceless. A great understanding of the source of the data is what engenders meaning within it. To someone who does not invest, the stock pages look like nothing but a semi-random collection of meaningless letters and numbers, yet these numbers represent a massive enterprise which can cause great men to cry or dance with glee. So, in proceeding forward, we must ask, "how can one distill data into a new format which provides context and power while showing it in a novel way which provokes a sense of mirth in the user?"

Continuing with plans to create more visceral responses to data in our users, we are currently exploring the possibility of working with non-traditional data-transfer senses- i.e. gustation and olfaction(taste and smell). Though data has historically been transferred nearly exclusively via sound-through speech and sonification, and vision - via written language and symbolic structures, there is evidence that taste and smell could also serve as routes for this transfer. These are senses that affect us on a more emotional, animalistic level and thus are open to the transmission of data intended to have a visceral impact. This paper shall

deal in general with the possibility of using taste and smell as a medium for data transmission and the aesthetic implications of creating such a device while dealing specifically with the employment of coffee and tea to transmit news data.

Background

There is a great deal of evidence to support the hypothesis that human beings may be capable of receiving messages encoded into the gustatory and olfactory senses. In terms of their evolution, taste buds and odor receptors are direct derivatives of the first chemoreceptors to appear on the membranes of single-celled organisms (Simon and Roper, 1993) and they are highly specialized to the point of differentiating between thousands of tastes and smells. Through detection of combinations of 2000 separate odors which human beings express receptors for, humans are able to distinguish millions of complex smells (Firestein, 2000). Likewise with taste, though there are only five basic tastes (bitter, salty, sour, sweet and umami), human beings are able to recognize millions of specific flavors. Complex interactions of specific chemical receptor agonists and antagonists create the resultant tastes which we experience these. The resultant experience of flavor is dependent upon the kinetics of the substance being tasted (Spielman, 2000). It is estimated that without context or standardizing tastes for calibration of the senses, human beings are capable of distinguishing concentrations of salt and sugar in solution to a value of 1.7 bits of information (Rogers and O'Connell, 1955). This suggests that chemical stimuli representing all five of the basic flavors could in theory express a great deal of data given a sufficient number of repeated applications in a short period of time. The kinetics of the chemical binding patterns to taste bud receptors suggest a flavor half-life of less than 200ms (Spielman, 2000) which is sufficient to suggest the serial transmission of at least 8 bits/second of information via taste mechanisms even when dealing with only two of the basic tastes and excluding additional information available through aroma. By mathematical analysis of this data, we hypothesize that the extension to all tastes would make data transmission rates of 15 kb/sec or nearly 1 kb/min physiologically possible.

The concept of delivering information in this manner is likely to seem ridiculous, or even pointless, to some individuals for a number of reasons. It would be very easy, some would reason, for such an endeavor to have emetic results. Associated with the sensation of taste is a feeling of security- taste, after all, protects us from ingesting toxins. Mammalian taste buds are related to the behaviors of salivating, swallowing, epiglottal closing, vomiting, face washing and head shaking among others (Simon and Roper, 1993). The concern that a device, which produces flavors for the purpose of data transmission rather than for the purpose of enjoyable taste, could produce unwanted side effects is an important factor to consider but not a

wholly valid argument. Perception of taste is largely a cultural phenomenon- the taste and smell of fermented mare's milk, such as is consumed in parts of central Asia, is entirely repellent to most Europeans, as is the flavor of natto, the fermented soy beans commonly consumed in Japan. The boundaries of acceptable taste are largely acquired, as is the ability to detect subtle nuance in tastes. Therefore, the prospect of conditioning individuals to be accepting of any taste which such a device would create is promising. However, considerations of appropriate taste are important to the aesthetics of the proposed device as it will be transmitting data only to unconditioned taste buds at this time. In order to not offend the taste of the user as it exists currently, a permanent and appropriate symbology of information would need to be formulated with discreteness of signal and overall palatability being of primary importance in its structure. Without this key piece of structure, vast amounts of data would be unable to be transmitted via taste with any regularity or reproducibility. However, the creation of such a system is beyond the exploratory bounds of this paper and as such, we must rely upon pre-existing taste symbology for the moment.

Data displays using output devices that appeal to gustatory or olfactory senses have been attempted before. One of the first such devices is the spice clock, invented in the late seventeenth century by M. de Villayer. Intended to allow the user to tell the time in the absence of light, it guides the user to a different spice for each hour so that time may be told by taste (Boorstin, 1985). A quite interesting way to deal with this problem, the spice clock was made obsolete by illuminated clocks. Smell has been attempted frequently as a user interface, but generally only to convey a direct sense of an object, usually in coordination with a still or motion pictures. The fact that smell has not been used to symbolically display data as such is not surprising as olfaction is unique in its neurobiological pathway, being connected directly to the limbic system and being less immediately available for cortical processing. In recent years there have been a number of proposed gustatory data displays. The edible user interface, first suggested by Benjamin Ishak Resner (Resner, 2001) as a method for humans to interface remotely with dogs via electronic interface, has been further developed by the works of such researchers as Dan Maynes-Aminzade whose BeanCounter and TasteScreen projects are attempts to use data to affect gustatory senses. While the BeanCounter project displays network drive data via jellybean dispensation, the TasteScreen uses flavored fluid dripped down a screen so that the user may lick it. While both of these projects approach gustatory data transmission in novel ways, there is still great development to be considered in this field before its widespread application might be successful. Primarily, we must consider the importance of creating edible or drinkable user interfaces that transmit data related to the medium of transmission at relatively high resolution. Furthermore, our research proposes that beverages are preferable to solid foods as data transmission vehicles due

to their fast action at the taste buds and ease of consistent delivery without need for mastication.

The need for an immediately palatable transmission medium capable of carrying a fairly complex message has led us to coffee. Coffee is a robust beverage whose aroma contains over 650 chemical compounds (Gelperin, 2002). The flavor of coffee contains sour, bitter, umami, and even recognizable sweet and salty components. Coffee is enjoyed around the world and is farmed in over 40 countries. It has a powerful flavor with nuances that vary greatly depending upon growing region, growing elevation, weather, roasting and shade. Although the ability to distinguish country of origin from the taste of coffee is not a widely held skill at the current point in time, it is a common ability among coffee connoisseurs. At a cupping, or coffee tasting session, it is often expected that the cuppers will be able, or at least attempt to, distinguish the origin of the beans from which the coffee was brewed. Some even boast the ability to recognize the exact elevations at which the beans were grown. It seems likely, therefore, that an average lay person, given proper conditioning, could easily distinguish between several coffees of different origins.



fig 1. Electra Micro Casa semiautomatic Espresso Machine

In this paper we explore the use of coffee as a medium for data transmission first through the application of a series of simple experiments intended to determine the likelihood of data transmission via taste and then through the process of designing a device to dispense this informatic beverage.

DESIGN

Foremost in the design of our device were the concepts of ease of use, mass accessibility of concept, if not necessarily of appeal, and conceptual unity. In choosing a data set to transmit via coffee, news presented itself as an



Figure 2. Traditional ibrik

ideal subject. Coffee is often enjoyed while reading or watching news in the morning or evening and coffeehouses have served as places where news is exchanged for centuries. Further, coffee, as a valuable commodity, has been a generator of news since shortly after it was first cultivated (and so closely guarded that seeds had to be smuggled out of the country), in Yemen in the sixteenth century.

Coffee is the second most valuable commodity after Oil in the world, currently amounting to roughly \$9 billion annually in sales in the United States alone. The worldwide coffee industry is estimated to employ over 30 million people (nearly .5% of the world population) and Coffee is the primary export of several countries in Latin America, Africa, and Asia. Recent collapses of coffee crops have left coffee producing countries such as Colombia, Vietnam and Ethiopia economically crippled.

Considering the massive impact that coffee may then have on the news, the delivery of news information through the medium of coffee maintains the concepts of unity and conceptual accessibility that the project is striving for. In choosing a material for the device, the opportunity to further fulfill our emphasis on unity was achieved through our selection of copper. There is a long history of copper being used to brew coffee dating back to the seventeenth century. During this time, in the Middle East, coffee was sold in the streets by pedlars carrying it in copper pots. The traditional ibrik(fig 2) used to serve Turkish coffee is crafted from copper as well. In modern times luxury Italian espresso machines(fig 1) are often manufactured from, or at least accented with, copper.

To fulfill our ease of use requirements, we have chosen a simple control and display system for the device itself consisting of 1 rotary switch for selecting news feed, two push buttons, one for brewing a cup and one for brewing a pot, and two indicator lights(fig 3). Coffee hoppers representing coffee growing regions and containing whole coffee beans grown in those regions are clearly labeled with a world map outline graphic with the region of interested filled in.

TECHNOLOGY

The News Brews system consists of technology elements both internal to the NewsBrews device and external. The logic contained within the device itself is minimal. The News Brews device houses a pic chip (18f252), which controls motors and communications, and a Lantronix Xport, which connects to outside servers via internet. The process of encoding the news into a cup of coffee requires 2 separate translation stages. The first is a reduction of text to pure data and the second is a translation from information which is easily readable by humans a format which is more easily used by machines.

Because the News Brews device is running off of a small microcontroller with limited logic abilities, it is necessary to use an external server for the task of parsing data from the news. For this task News Brews employs common gateway interface(cgi) scripts written in perl. The cgi scripts connect to the servers housing the news feeds and count occurrences of various countries in the news that day. Perl is a language ideally suited to completing this type of task with utmost efficiency. The first script we created for this purpose delivers extensive information about the exact number of occurrences of each search word in the news, specifically the New York Times. This script proved necessary for determining the accuracy of the code (currently, a minor variant of this code is under development to store detailed results in a database for future analysis). This same raw information is tabulated and fed to the News Brews Device through a nearly identical cgi. However, information must be transmitted to

the News Brews device in an exceedingly simple form, so the News Brews device receives only a short string of comma delimited characters which defines the percent of the daily news originating in each of 6 regions: Region 1: Central and South America, Region 2: Sub-Saharan Africa, Region 3: Middle East and Northern Africa, Region 4: Central and South Asia, Region 5: South East Asia, and Region 6 : Pacific.

Because the tree structures of different news feeds are different, the addition of a user selectable news feed mandated separate cgis for each feed. The NYT news feed is the most simple to parse as it delivers the full contents of the paper via XML. The BBC and FOX cgis are slightly more difficult to parse as they provide only headlines in XML which link to HTML pages. The News Brews device uses the "GET" function over HTTP protocol to connect to the server(nyu stage) housing the cgi scripts and requests information from whichever news feed the user has selected. The cgi script then prints the information back via HTTP connection in a browser readable format(for debugging). The Pic microcontroller waits for the string "<Body>" before beginning to capture text.

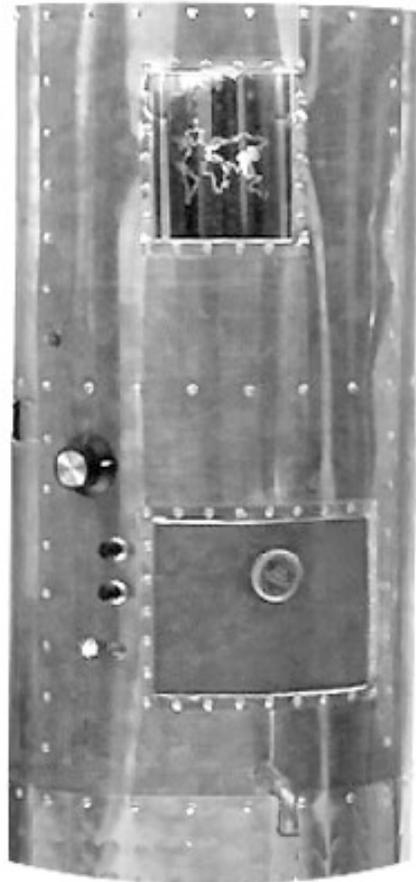


figure 3 the NewsBrews device

Once the News Brews device receives the news information it has requested from the cgi script, it uses this information to drive two motors, one stepper and one servo. Hoppers housing selected coffee varieties from each of the 6 regions are kept in a carousel at the top of the device. Driven by the stepper motor, these hoppers rotate past a window in which they can be viewed by the user and are repeatedly passed over a small opening with a servo operated door mechanism. The door mechanism opens into a chute which delivers coffee beans to the hopper of a grinder where they await pulverization. Once ground, the beans are deposited in a user-replaceable paper filter where boiling water is pumped over them producing a cup of coffee which is dispensed out of a nozzle at the front of the apparatus.

METHODS

For purposes of defining the differences in taste which users of the NewsBrews device might experience, we first evaluated the news feeds which would provide source data for brewing. The New York Times was monitored daily for 3 weeks to verify that coffee composition might vary significantly from day to day. The results of this research are shown in figure 4. In addition, the BBC world Service and FOX news feeds were monitored for a period of 1 week for comparison against the New York Times.

In order to determine the validity of the premise that differences between coffee blends could be successfully identified by users, a simple set of experiments was employed. Due to scheduling, these experiments unfortunately could not be conducted using the News Brews device to brew the coffee. Instead, coffees were prepared by human researchers according to recipes specified by the News Brews cgi scripts. All coffees prepared for the experiments were ground freshly to drip consistency and brewed by pouring boiling water directly over the fresh grounds (6oz water/tbsp coffee) then post filtering with a no. 2 coffee filter.

Subjects were selected to participate in coffee tasting experiments and were kept blind to the identity of all samples they were presented with. Two separate groups participated in the experiments. All of the subjects reported being coffee drinkers but none were willing to label themselves as “connoisseurs.”

In experiment 1, seven subjects were asked to drink two coffee blends in succession and determine whether they were different. Each subject tasted three pairs of coffees, blended according to our regional content parameters.

Subjects were first presented with News Brews coffee blends, generated from the NYT April 13 and April 20 news feeds, side by side. A second pairing was that of the BBC news feed against the New York Times news feed, both determined on April 20. In a third pairing, intended to determine any placebo effect, subjects were presented with

two of the same coffee blend- both being generated from the BBC world service feed on April 20.

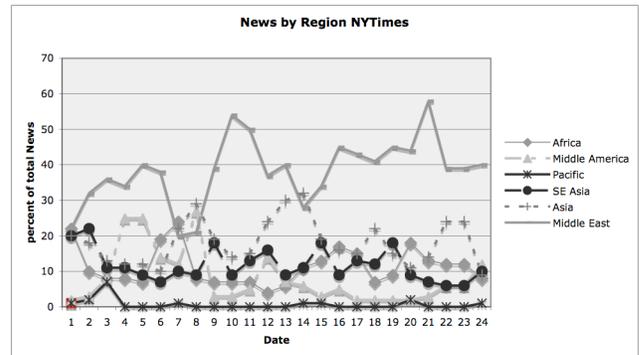


figure 4.

In experiment 2, eight subjects were trained to taste specific coffees by being provided with samples of pure brewed selected coffees (Vietnamese, Guatemalan Maragogipe, Tanzanian peaberry, and Yemeni Mocha Java). They were

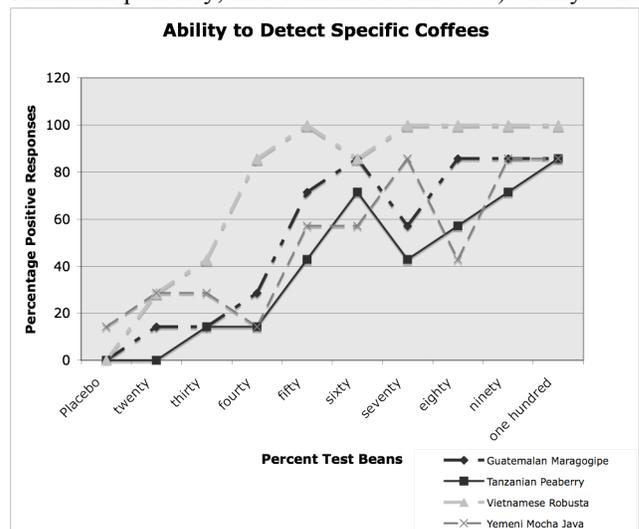


Figure 5

then asked to determine whether these coffees were present in a second set of ½ oz samples supplied to them in random order. Each sample in the second set contained a different percentage of one of the selected coffees delivered in a vehicle of Chock Full o’ Nuts brand coffee. The subjects were allowed to taste the training samples as often as they felt necessary before the start of the test but these samples were removed once testing began.

RESULTS

Design Results

The design of the NewsBrews prototype required massive compromises. In order to make the object functional, it was necessary to off-center the access door- a necessary but unfortunate consequence of using hacked objects(Black and

Decker grinder, peristaltic pump) on the inside. The choice to use rivets as fasteners, while aesthetically pleasing also proved a massive engineering challenge. In dealing with everyday objects, few things are more frustrating than objects designed to prevent user servicing or tampering. In creating such a complex apparatus, it was crucial to design the News Brews device such that it could be entirely disassembled. The use of rivets clearly makes this a troublesome proposition as they are by nature non removable.

Further, it is often difficult to estimate how something may operate in the real world. Coffee beans are irregularly shaped objects which easily get stuck when being dropped through holes and are strong enough to prevent rotation of the News Brews platform, which is driven by a high torque stepper motor. Careful tuning of hole sizes and hopper angles was sufficient to reduce the dispensation failure rate to percent, but total prevention of bean dispensation failure has so far proved impossible. We believe that the implementation of an additional mechanism to agitate the coffee beans within the hopper at the time of dispensation could possibly solve this irregularity.

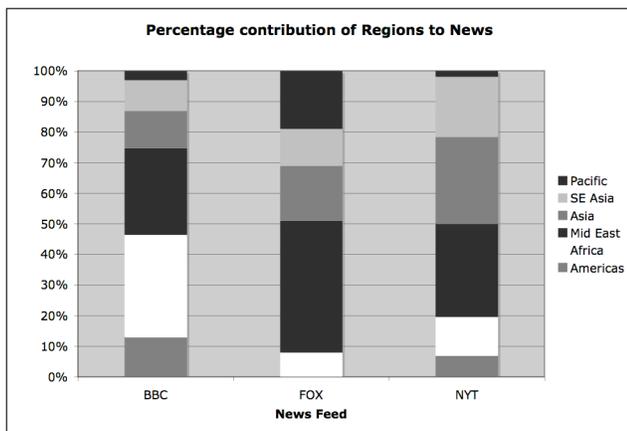


figure 6.

Regardless of difficulties, the aesthetics of the NewsBrews device has so far proved successful to whatever extent such can be measured. Responses to it's design have been overwhelmingly positive- the device has been described voluntarily as "amazing" and "beautiful" and "crazy" repeatedly. In addition, the coffee that the NewsBrews device dispenses has been referred to as "surprisingly pretty good," or "a serious cup of coffee" by respondents. This is in contrast to the original News Brews beverage concept which mixed coffees and teas, and was referred to by tasters as "not very good," "unexpected," or "different."

Experimental Results

Our news sources vary significantly over time as shown in figure 4. It is notable that though the composition of the news, and therefore the coffee, was largely(roughly 40% on

average) Middle Eastern, there were times at which South and Middle America showed a higher dominance. In addition, there have been individual cases since in which South East Asia was more represented than the Middle East. In addition, BBC FOX and New York Times news feeds vary heavily from each other (fig 6).

As shown in figure 6, the task of differentiating coffee blends created by news brews methods proved easy for most of the participants. Five of the seven subjects claimed an ability to differentiate between the April 13 and April 20 New York Times blends and six of seven claimed an ability to differentiate between the BBC and New York Times blends. However, one participant found that the two identical samples were different as well, indicating that some placebo effect was present in the testing methods.

The second experiment showed that in higher concentrations, certain coffees were almost universally recognizable(fig. 5). The presence of Vietnamese coffee, for instance, could be sensed by almost all participants by the time it reached 40% concentration. Nearly all coffees were identifiable by the majority of subjects by the time they reached 60% concentration. Only one subject responded positively to the presence of a coffee when they were given a sample of pure vehicle. One of the subjects was able to detect all but the Tanzanian Peaberry at a 20% concentration and responded correctly to 34 Of 40 tests. Another of the test subjects responded negative to all but higher concentrations of Vietnamese coffee.

DISCUSSION

Though limited by sample size, our primary experimental results show interesting trends in the ability of individuals to benefit from taste-based data transmission. The fact that one subject was able to consistently identify coffees, even at low concentrations, when compared with the subject who

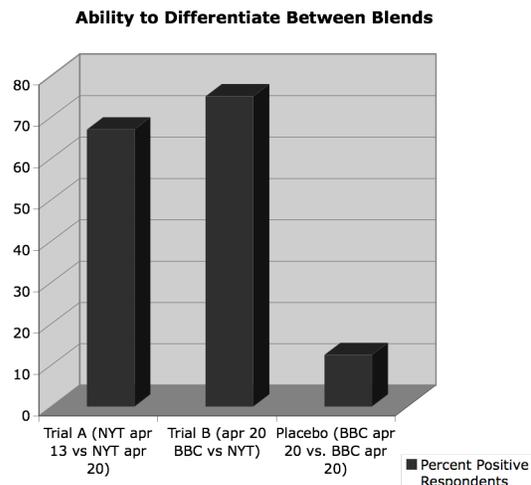


Figure 7.

could identify only the presence of Vietnamese coffee, suggests that there is a wide range of sensitivities to taste in the population. Whether this sensitivity is primarily genetic or experience based is beyond the scope of this paper. In either case, there is evidence to suggest that some individuals are fully capable of benefiting from gustatory data transmission immediately. It further suggests that additional research into specific coffee varieties might be useful in selecting a set of coffees distinctive enough to be more readily identifiable by users.

While the identification test was conducted on individual coffee samples and could be proven incompatible with the real world beverages dispensed by the NewsBrews device, the differentiation test shows to some extent that taste buds are not overwhelmed by the blending of complex flavors. Given the limited training period of the test subjects, it is reasonable to conclude that with sufficient training, response accuracy could be advanced greatly.

CONCLUSIONS

Early experimental results, though limited by sample size and physical constraints seem to indicate the possibility that the exchange of small amounts of data via gustatory transmission is possible and could be a useful tool. Evidence also suggests that even greater encoding could be achieved with proper training of users and more advanced selection of coffee beans.

Further research must be completed before determining the exact extent to which a cup of informatic beverage is decipherable by users and the actual threshold of data which could be successfully transmitted in this manner. Once this groundwork has been completed, further research may be proposed to examine the total amount of data we may effectively encode into taste based data displays.

The NewsBrews device has shown a successful deployment of concept and promise for further development. In addition, it has demonstrated that informatic beverages may be produced in an automated manner without compromising gustatory aesthetics. Extensive testing will follow shortly.

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