



CASE: M-347  
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## STAR DIGITAL: ASSESSING THE EFFECTIVENESS OF DISPLAY ADVERTISING

### BACKGROUND

Star Digital is a multichannel video service provider with over US\$100 million in annual advertising spends. Its advertising goals range from brand building to increasing package sales. Even though most of its advertising dollars traditionally went to TV, by 2012/13 Star Digital was gradually increasing the share of online advertising spend, especially in banner ads. This was mainly due to two reasons: i) many potential customers who did not currently have a service provider spent a significant part of their time online, and ii) customers were increasingly turning to the internet to consume media and purchase goods and services. Star Digital was very active in managing this substantial advertising budget. Understanding the return on its investment in each media has been key to its spending decisions.

John Wanamaker, the pioneering marketer and advertiser, famously said, "Half the money I spend on advertising is wasted; the trouble is I don't know which half." This has been generally true in offline advertising, where a lack of data tying ad impressions to conversions (e.g. purchases) made ad effectiveness measurement problematic. The internet, on the other hand, provides a platform that is far better in its potential to measure ad effectiveness because it enables marketers to make the connection between ad impressions and conversions at the customer level.

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Professor Sridhar Narayanan, Associate Professor of Marketing at Stanford Graduate School of Business and Dr. Taylan Yildiz, Head of Display Advertising Research at Google Inc. prepared this case as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. The case study is based on data from an online advertising study for a real firm, but the name of the firm, and some elements of the data have been disguised for purposes of confidentiality.

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Even with the availability of online advertising data, measuring display ad effectiveness has proven to be difficult. In the early days of internet advertising, display ads were valued by their click-through conversion rate, i.e., the rate of generating sales (more generally referred to as conversion in the online advertising industry) following banner clicks. This approach tends to incorrectly value the return to advertising, since it attributes conversion entirely to clicks. It is likely that many consumers view the advertisement, but don't click on it. Yet, the advertisement may have influenced them to make a purchase—the industry refers to this as view-through conversion. This effect of advertising on conversion is not accounted for by looking at click-through conversion rates, thereby undervaluing the return to such advertising. In order to account for view-through conversions, reporting tools were developed where any impression that is followed by a conversion got the credit for helping a user convert. This approach, contrary to the click-through conversion criteria, tends to overvalue advertising since ad exposures can occur by coincidence, and conversions can happen regardless of users' seeing the ads.

To measure the causal effect of display advertising on sales conversion, one needs to measure what users would have done if they had not seen the campaign ads. A controlled experiment, where consumers are randomly assigned to the test group that sees the advertisements and a control group that does not, is the gold standard to measure the increase in conversions due to the display ad campaign. Star Digital recognized this fact and designed a controlled experiment to measure the effect of display advertising for one of its advertising campaigns.

### Star Digital's Display Advertising Experiment

In 2012, Star Digital designed an online display advertising campaign run on six websites with the primary objective of increasing subscription package sales. It also was interested in website visits as a proxy for measuring brand impact. Having been aware of the issues with click-through and view-through-based ad effectiveness metrics, Star Digital designed an experiment that measured the *incremental* impact of advertising on the outcome of interest, i.e. sales.

The experiment worked as follows: Before the first campaign ad was to be served to a user, s/he was assigned randomly to either the test group or the control group. The consumers in the control group were shown an advertisement for a charity organization in place of the advertisement for Star Digital, whenever their online actions prompted the serving of an ad. Banner advertising is typically served through ad-serving software,<sup>1</sup> which determines whether a consumer browsing on a particular web page is eligible to be shown that ad or on. In this experiment, the ad-serving software was programmed to then check if the consumer was in the predetermined control group or the test group. If the consumer was in the test group, the advertisement for Star Digital would be shown. If the consumer was in the control group, the software would intervene and replace the Star Digital advertisement with an advertisement for a charity organization. The assignment to the test or the control group was permanent. In other words, a control group user was never exposed to a Star Digital ad from this particular campaign, while the users in the test group were shown advertising from Star Digital's advertising campaign as per the normal process and never the charity advertisement in place of the Star Digital advertisement.

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<sup>1</sup> Ad serving software, such as Google's Doubleclick software solution, serves as an intermediary between advertisers and websites with advertising real estate, by deciding which advertisement to show to which consumer.

An important decision for Star Digital was the size of the control and test groups in this experiment. The simplest choice was to randomly assign consumers to test and control groups of equal size. However, this was an expensive option, since charity ads cost the advertiser as much as the campaign ads, since the advertiser paid for advertisements served to the control group as well. There was also an opportunity cost incurred when a consumer who could have been served an advertisement for Star Digital's campaign, and who could have been influenced by these advertisements to sign up for its subscription service, was shown charity advertisements instead. Thus, Star Digital needed to carefully decide on the proportion of consumers to be assigned to the control group, so as to get a statistically valid comparison at minimum cost.

The fraction of users assigned to the control group depended on four major factors:

- **Baseline conversion rate:** If users naturally convert at high rates, then the fraction can be small because the control users will generate enough conversion events to detect statistically significant campaign impact. For example, for a given size of the control group, it is usually easier to detect the effect on website visits compared to sales as visits typically happen more frequently than sales. Advertisers might not know the baseline conversion rate in advance for a future campaign, but even an estimate of this rate would be useful for the purpose of deciding on sizes of control and test groups.
- **Campaign reach:** The larger the campaign, the lower the control percentage can get to achieve the same confidence in detecting the effect of advertising on conversion. As is the case with high baseline conversion rates, campaigns with high reach generate adequate numbers of conversions for both test and control groups. Showing advertisements to more users increases the number of control group conversions, assuming a fixed baseline conversion rate, and thus reduces the control group's fraction.
- **The minimum lift that the advertiser cares to detect:** The *lift* refers to the incremental effect of the advertising campaign. Detecting a small lift with statistical significance comes at the expense of having to use a large control group. Choosing the smallest lift yielding positive ROI minimizes the cost of the charity ads.
- **Power of the experiment:** An experiment's power is the probability it will detect a lift if one actually exists. An experiment achieves greater power if a larger number of consumers are placed in the control group.

Star Digital considered these factors and determined that in its experiment, 10 percent of the consumers would be placed in the control group, and the remaining 90 percent would be placed in the test group. With this experimental design, it ran the campaign with advertisements shown across six websites. During the course of the campaign, it delivered 170 million impressions to about 45 million users over a period of two months in 2012. As mentioned earlier, the campaign's main objective was to generate subscriptions to a package offering, but they were also interested in generating interest in the brand by bringing users to their website.

The data for the consumers who were part of this experiment, both in the experimental and control groups, was tracked. For the purpose of analysis, a sample was drawn since the original database was very large. Furthermore, since the conversion rate was small (only 0.153 percent of the consumers in total, including both the control and test groups, purchased), the sample that was drawn was a choice-based sample. Of the analysis sample, 50 percent consisted of people who had chosen to purchase the subscription package of Star Digital, while the remaining 50 percent consisted of those who had not purchased the package. However, whether the person belonged to the control group or test group was random in this sample. The data for this experiment are in the file star.dta. **Table 1** gives a description of the variables in this dataset.

**Table 1**  
**Data Description**

Variable Name	Description
purchase	A dummy variable indicating whether the consumer eventually purchased at Star Digital or not =0 if there was no purchase =1 if there was a purchase
imp_1	The number of ad impressions for either Star Digital or the charity that the consumer saw at website # 1
imp_2	The number of ad impressions for either Star Digital or the charity that the consumer saw at website # 2
imp_3	The number of ad impressions for either Star Digital or the charity that the consumer saw at website # 3
imp_4	The number of ad impressions for either Star Digital or the charity that the consumer saw at website # 4
imp_5	The number of ad impressions for either Star Digital or the charity that the consumer saw at website # 5
imp_6	The number of ad impressions for either Star Digital or the charity that the consumer saw at website # 6
test	A dummy variable indicating whether the consumer was in the test or control group =0 if the consumer was in the control group =1 if the consumer was in the test group

The cost of advertising at Sites 1 through 5 is \$25 per thousand impressions, while the cost of advertising at Site 6 is \$20 per thousand impressions. While the advertiser cannot control which of Sites 1 through 5 it can advertise on (these sites are part of a single ad network and the ad serving software automatically decides which site the advertisement appears on within the network), it does have the ability to specify if the advertising should appear on Site 6 or Sites 1 through 5, or both these options. A purchase results in a lifetime contribution of \$1,200 for Star Digital.

You have been asked by Star Digital to assess the following:

1. Is online advertising effective for Star Digital?

2. Is there a frequency effect of advertising on purchase? In particular, the question is whether increasing the frequency of advertising increases the probability of purchase?
3. Which sites should Star Digital advertise on? In particular, should it put its advertising dollars in Site 6 or in Sites 1 through 5?