

Rocket Fuel: Measuring the Effectiveness of Online Advertising

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The Case in Hand

Rocket Fuel

Provides digital advertising services. Focus on utilising big data and AI to exploit the potential of real-time bidding (RTB) and ad exchanges.

HQ: San Francisco, USA

- Year founded: 2008
- Ticker: NASDAQ: FUEL
 - Revenue: \$500 Million



Brief Description of Campaign:

Clara Demidenko prepares for a client meeting with **TaskaBella (manufacturer** of women's luxury accessories). The objective of the meeting is to convince TaskaBella that the pilot ad campaign which Rocket fuel recently completed was effective and subsequently to **present evidence** that their advertising offers a **positive ROI**. The stakes are high because TaskaBella is in the process of **reallocating** a large proportion of its advertising **budget** on this product.

The primary objective of the campaign was to target half a million online consumers with ads for TaskaBella's new handbag. In the first meeting between the two companies much of the conversation focussed around **measuring the success of the campaign**. TaskaBella were most concerned about achieving **sufficiently high conversion rates**, so that advertising dollars led to **enough purchases to justify spend**.

Demidenko set out the costs of impressions making it clear that cost per thousand (CPM) were impacted by several factors but with the sites and target population that TaskaBella had in mind they should expect to pay **\$9 for 1,000 impressions**. TaskaBella estimated that given the \$100 price of the new bag and given the variable costs associated with each unit, a converting user is on average worth \$40.

Worth of \$40 per converted user is calculated by taking the marginal revenue (\$100) of each handbag sold less the marginal costs associated with each handbag (material, labour, commission, etc.). These variable costs do not include fixed costs such as advertising.

Measuring success: Further Detail

TaskaBella estimated that at a CPM of roughly \$10 would translate to a cost of \$10-\$15 per conversion.

However, Adam Burrup highlighted that TaskaBella already had a strong social media presence meaning many customers may actually buy the bag as a result of word of mouth. Thus, it was important to him to understand the **extent to which conversions can be attributed to the campaign** (and not due to general social media attention/ reputation).

Demidenko agreed and suggested that Rocket Fuel should provide **evidence that the ads really do make a difference**. This was to be done by carving out a small proportion of users reached during the campaign to form a **control group**. Users in this control group will be shown a public service announcement (PSA) instead of the ad, in the exact same size and position on the page. By randomly selecting which user is in the control group and which users are exposed to the real ad Rocket Fuel can **measure the extent to which the advertising makes a difference**.

It was agreed the control group size would stand at 4%. Obviously the **control group represents an opportunity cost** for TaskaBella because serving PSA's to users costs money and represents a lost opportunity to convert potential customers and so they do not want the control group size to be too large.

Demidenko had experienced firms which wanted to reduce the size of the control group and so knew what to do. She explained that conversion rates in display advertising are typically low, meaning a sizeable control group is needed to detect lift and secondly even if the advertising is effective the lift might be small. If the control group is small and the lift is very small the experiment will not be able to detect a significant lift. Finally, she described that a larger control group allows for more detailed analysis with potentially significant differences in different segments of the population.



Measuring extent of advertising impact.

Requires control group. Which is an opportunity cost.

> TaskaBella would therefore prefer smaller control group.

Example Public Service Announcements (PSA)

Example 1.



Example 2.



The Process

1. The ads were first loaded into Rocket Fuel's content delivery network by an operations associate, which enables the quick displaying of the ads anywhere in the world within milliseconds.



2. When the user visits a publisher's page (like CNN.com or NYtimes.com), the publisher partners with a supply-side vendor to put the impression opportunity out to auction. This all happens millions of times per second across the dozens of such exchanges that **Rocket Fuel is** integrated with.

3. Rocket Fuel receives a hashed cookie ID in the bid request, which allows it to anonymously identify the user in its system, along with many other parameters about the ad size and content. It then applies ML models to predict the probability that this user will take the required action or actions for each of its campaigns running at the time of the bid. For each campaign, users that have been assigned to the control group are not actually served a campaign ad, but a PSA.



User id: Unique identifier of the user.

Test: Whether the user was exposed to advertising or was in the control group (1=exposed, 0=control).

Converted: Whether the user converted. 1 if the user purchased the bag during the campaign, 0 if not.

Tot_impr: Total number of impressions the user encountered. For users in the control this is the number of times they encountered a PSA. For exposed users this is the number of times they were shown the ad.

Mode_impr_day: Shows the day of the week the user encountered the most number of impressions.

Mode_impr_hour: Shows the hour of the day in which the user encountered the most number of impressions.

Was the advertising campaign effective? Did additional consumers convert as a result of the ad campaign?

The trial campaign ran from November 2015 to February 2016.

- Test = 1 if the user was exposed to the real ad
- Test = 0 if the user was in the control group (PSA)
- Total Number of exposed users = 564,577
- Total Number of exposed conversions = 14,423
- Conversion percentage of exposed users = 2.5547%
- Total Number of control users = 23,524
- Total Number of control user conversions = 420
- Conversion percentage of control users = 1.7854%

In terms of conversion, yes the ad campaign was successful. Approximately 0.769% (2.555-1.785=0.769245) of consumers bought the handbag as a result of the ad campaign.



Was the Ad Campaign Profitable?

A. How much more money did TaskaBella make by running the campaign (excluding advertising costs)?

Profit = A * B * C

A= Conversion rate of exposed users - Conversion rate of control group B= Number of exposed users C= Value of converted user

 $\pi = (2.5545\% - 1.7854\%) * 564,577 * $40 = $173,719.21$

B. What was the cost of the campaign?

 $Cost = \frac{A}{1000} * B$ A= Total number of impressions
B= Average cost per thousand (CPM)

$$\pi = \frac{14,597,182}{1000} * \$9 = \$131,374.64$$

A. Calculate the ROI of the campaign. Was the campaign profitable?

$$ROI = \frac{Net \ Profit}{Cost} * 100$$

$$\text{ROI} = \frac{42,344.57}{131,374.64} * 100 = 32.231\%$$

The above calculations illustrate that the campaign was indeed effective in delivering increased conversion rates and boosting TaskaBella profits. Given the positive ROI we conclude the campaign was profitable.

D. What was the opportunity cost of including a control group; how much more could have TaskaBella made with a smaller control group or not having a control group at all?

Opportunity Cost = A * B * C

A= Conversion Rate of exposed users - Conversion rate of control users B= Number of users in control group C=Value of converted user

Opportunity *Cost* = 0.769245% * 23, 524 * \$40 = \$7238.29

Question 3



How did the number of impressions seen by each user influence the effectiveness of advertising?

In order to analyse the impact of the number of impressions on the effectiveness of advertising I have split the users into groups. Starting from 0-30 impressions and going up in 30' s until 210 impressions. There are far fewer people who viewed more than 210 impressions and hence those who received 210 or more form the upper band group. To measure the effectiveness of advertising we simply look at the conversion rate. This is calculated as the number of conversions in the group divided by the number of people in the group. Note that initially as the number of impressions people are exposed to rises the conversion rate also rises. However, we seem to reach a turning point at about 150 impressions. After this it seems that more impressions actually results in a lower conversion rate.

Group	Group Size	Conversions	Conversion Rate
1-30	457,381.00	3,151.00	0.69%
31-60	77,335.00	3,823.00	4.94%
61-90	25,590.00	3,187.00	12.45%
91-120	11,293.00	1,926.00	17.05%
121-150	5,825.00	1,037.00	17.80%
151-180	3,304.00	567.00	17.16%
181-210	2,024.00	323.00	15.96%
210+	5,349.00	829.00	15.50%

Question 3

How did the number of impressions seen by each user influence the effectiveness of advertising?



The above chart shows the average number of impressions shown per conversion in each group. Its pattern seems to mirror that of the previous chart. It illustrates that as the number of impressions shown increases, so too does the number of conversions, meaning that initially as the number of impressions rises the number of impressions shown per conversion actually reduces (and hence the effectiveness of advertising is increasing). As in the previous chart after 150 impressions this pattern reverses meaning that the average number of impressions shown per conversion increases suggesting advertising is becoming less effective.

			Impressions per
Group	Impressions Served	Conversions	Conversion
1-30	4,770,365.00	3,151.00	1,513.92
31-60	3,261,125.00	3,823.00	853.03
61-90	1,875,987.00	3,187.00	588.64
91-120	1,171,092.00	1,926.00	608.04
121-150	779,726.00	1,037.00	751.91
151-180	543,154.00	567.00	957.94
181-210	394,103.00	323.00	1,220.13
210+	1,801,630.00	829.00	2,173.26



How does the consumer response to advertising vary on different days of the week and different times of the day?

First, I have simply examined the conversion rates in each group (ie conversion rate of those whose mode is Monday, Tuesday, etc.). From this simple chart we can see that consumer response to advertising seems most encouraging early in the week (ie Monday and Tuesday) then fades off later into the week before picking back up again slightly on Sunday. It might be that those whose mode is a Monday saw far fewer or far more impressions. So to measure effectiveness we should also consider the volume of impressions shown per group.

Mode Day	Group Size	Conversions	Conversion Rate
1	87073	2857	3.3%
2	77479	2312	3.0%
3	80908	2018	2.5%
4	82982	1790	2.2%
5	92608	2057	2.2%
6	81660	1719	2.1%
7	85391	2090	2.4%



How does the consumer response to advertising vary on different days of the week and different times of the day?

In this second chart I have considered the total number of impressions each group saw (ie total number of impressions those in the 'Monday mode group' saw). This is then divided by the total number of conversions in that group to give us the average number of impressions per conversion in each group. Put otherwise this figure tells us the average number of ads each group saw for one conversion. Lower figures obviously suggest more effective advertising. This chart therefore complements the pattern witnessed in the previous chart. We confirm that advertising seems to be more effective at the start of the week (Monday/ Tuesday where the average impression per conversion is >800) and less effective later in the week (Friday/ Saturday where the average impression per conversion is \approx 1,200.

Note that when simply considering conversion rates it seems that Thurs, Fir and Sat are all pretty much equally as ineffective as each other. However, when taking into account the number of impressions each group saw and thus considering the impressions per conversion it is clear that Friday and Saturday seem worse. Two explanations can be that they were more in the group or they saw fewer impressions. The most obvious explanation to me seems they saw few impressions ≈320,000 fewer than average of Friday/ Saturday

How does the consumer response to advertising vary on different days of the week and different times of the day?

			Impressions per
Mode Day	Impressions Served	Conversions	conversion
1	2,205,430.00	2,857.00	771.94
2	1,853,721.00	2,312.00	801.78
3	1,985,418.00	2,018.00	983.85
4	1,944,173.00	1,790.00	1,086.13
5	2,464,496.00	2,057.00	1,198.10
6	2,060,091.00	1,719.00	1,198.42
7	2,083,853.00	2,090.00	997.06



How does the consumer response to advertising vary on different days of the week and different times of the day

When considering consumer response to advertising at different times of day I have used the same process as was done for the days. First , we consider conversion rate among each group. From the chart above it seems that advertising is more effective from mid afternoon to the evening (15:00- 21:00). Within this timeframe the conversion rate in each group is consistently above 2.5% and is at its maximum at 16:00 where it goes above 3%. Unsurprisingly, advertising seems least effective in the early hours of the morning reaching a trough at 02:00 where the conversion rate stands at 0.7%. Again it might be that those whose mode is a 12:00 saw far fewer or far more impressions. So to measure effectiveness we should also consider the volume of impressions shown per group.

How does the consumer response to advertising vary on different days of the week and different times of the day

Mode Hour	Group Size	Conversions	Conversion Rate
0	5,536	102	1.8%
1	4,802	62	1.3%
2	5,333	39	0.7%
3	2,679	28	1.0%
4	722	11	1.5%
5	765	16	2.1%
6	2,068	46	2.2%
7	6,405	116	1.8%
8	17,627	344	2.0%
9	31,004	595	1.9%
10	38,939	838	2.2%
11	46,210	1,022	2.2%
12	47,298	1,127	2.4%
13	47,655	1,176	2.5%
14	45,648	1,281	2.8%
15	44,683	1,325	3.0%
16	37,567	1,156	3.1%
17	34,988	987	2.8%
18	32,323	885	2.7%
19	30,352	811	2.7%
20	28,923	862	3.0%
21	29,976	867	2.9%
22	26,432	690	2.6%
23	20,166	457	2.3%

How does the consumer response to advertising vary on different days of the week and different times of the day

When considering the total number of impressions each group saw and dividing by the total number of conversions in that group we obtain the average number of impressions per conversion in each group.

Looking at the chart we see that once again advertising seems least effective in the early hours of the morning . For the group whose modal hour was 02:00 on average they saw 3387 impressions per conversion. This is a stark contrast to the late afternoon where for those in the group whose modal hour was 16:00 it only took 272 impressions on average per conversion.



Ads per conversion

How does the consumer response to advertising vary on different days of the week and different times of the day

			Impressions per
Mode Hour	Impressions Served	Conversions	conversion
0	126,104	102	1,236
1	120,914	62	1,950
2	132,099	39	3,387
3	60,896	28	2,175
4	24,124	11	2,193
5	33,391	16	2,087
6	86,532	46	1,881
7	199,935	116	1,724
8	423,747	344	1,232
9	728,186	595	1,224
10	983,277	838	1,173
11	1,150,746	1,022	1,126
12	1,235,256	1,127	1,096
13	1,219,675	1,176	1,037
14	1,108,586	1,281	865
15	1,133,132	1,325	855
16	840,317	1,156	727
17	848,487	987	860
18	824,967	885	932
19	774,655	811	955
20	763,016	862	885
21	766,059	867	884
22	605,774	690	878
23	407,307	457	891

Taking the Analysis Further

Some suggestions for more advanced analysis of questions 3 and 4:

How did the number of impressions seen by each user influence the effectiveness of advertising?

Here we could run a simple logistic regression to try and predict the impact of the number of impressions shown on the probability of conversion. To account for the non-linearity of the relationship our previous analysis indicated I would suggest having both number of impressions and number of impressions².

$y = \alpha + \beta_1 Tot_impr + \beta_2 Tot_impr^2 + \epsilon$

Alternatively, we could divide the impressions data into groups (as was done before) and have a variable for each group.

 $y = \propto +\beta_1 [Tot \ impr \ 0 - 30] + \beta_2 [Tot \ impr \ 31 - 60] + \dots + \epsilon$

How does the consumer response to advertising vary on different days of the week and different times of the day?

Here we could simply build on the logistic model described above by adding in 6 dummy variables for the day and 23 for the hour (note in each case we should leave one day/ hour out of the model to avoid perfect collinearity between independent variables). Additionally, we could add in an interaction terms between these dummy variables which indicate the day/ hour this will allow us to see if the impact of the time of day changes on different days. Finally, interacting these dummy variables with the 'impressions' explanatory variable (allowing for different slopes) would allow us to see if the returns to the number of impressions differed across days or hours of the day.

 $y = \propto +\beta_1 Tot_{impr} + \beta_2 Tot_{impr}^2 + \beta_3 [Day 2] + \beta_4 [Day 3] + \dots + \beta_9 [Hour 1] + \beta_{10} [Hour 2] + \dots + \beta_{32} [Day 2 . Hour 1] + \beta_{33} [Day 2 . Hour 1] + \dots + \beta_x [Tot_impr * Day 2] + \dots + \epsilon$

A Ban on Ads for Environmentally Damaging Products

In June headlines read "After nine months of deliberations, a citizens' council set up by French President Emmanuel Macron to explore measures for cutting carbon emissions urged the French leader on Sunday to hold referendums on adding environmental protection to the Constitution and making the destruction of nature a crime."

The Convention Citoyenne pour le Climat (CCC) was convened by President Emmanuel Macron in 2019 following the gilet jaunes movement. "We do not include our fellow citizens sufficiently in the transparent, debated construction of the solutions we put forward. So that is the idea behind the Citizens' Assembly process," Macron said at a meeting of the CCC in January.





Samuel Murphy Case Study At the forefront of the CCC's suggestions is a call for 'ecocide', or the extensive damage of ecosystems, to become a crime in France. The group suggests that the decision to introduce climate protections into French law should be made by a referendum.

Borne said she was in favour of a referendum on the CCC's recommendations saying it would make it possible to "share the work" of the convention with the French people. Other measures called for by the group include stronger limits on advertising, with a ban on billboards touting products with a high carbon footprint such as large SUVs; banning genetically modified crops; higher taxes on nitrogen fertilisers; and halving the use of pesticides by 2030 and banning the most dangerous ones by 2035. The list also proposes a ban on heating outdoor café terraces and keeping shop lights on at night. France's minister for environmental transition, Elisabeth Borne, who received the proposals on behalf of the government, welcomed the committee's "ambition".