

## Chapter 15: "What if" Thinking Helps: Advanced Spreadsheets for Planning

Fluency with Information Technology  
Third Edition

by  
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## Designing a Spreadsheet

- When a spreadsheet is used repeatedly, it becomes a tool of planning, analysis, and decision-making
- Must be well designed and flexible to be effective

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15-2

## The Trip

- Driving trip to the Arctic Circle from Chicago
- Make a spreadsheet to figure out how long it will take and how much it will cost

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15-3

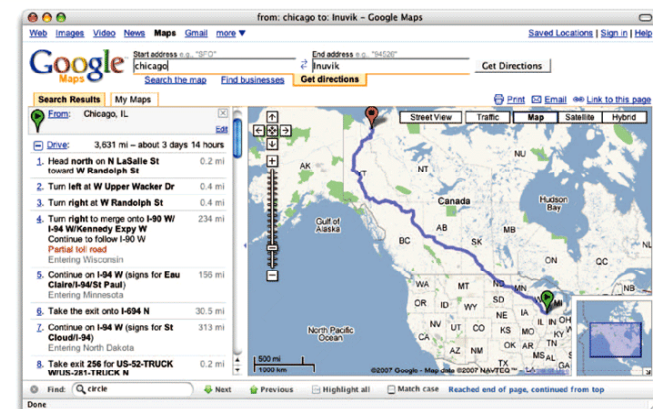


Figure 15.1 Google map directions for a trip from Chicago, Illinois (green pin), to Inuvik, Northwest Territories (red pin).

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15-4

## Design Guidelines

- Focus on Form
  - Make the form logical, the layout clean, and the entries clear and understandable
    - Descriptive info should be on the top and left
    - Summary info should be on the bottom and right
      - Use different fonts, colors, separate sheet for each table
- Explain Everything
  - It should be possible to know immediately what every cell means

## Initial Spreadsheet: Applying the Rules

- Focus on Form:
  - title, authors, completion date, column headings, color, clean font, data aligned
- Explain Everything:
  - comments added to cells (*Insert > Comment*)

**Trip to the Arctic Circle**  
by Pat and Alex; completed 23.June.07

Segment	Time Est.	Miles	Fuel Price Report	Fuel Price
Chicago to Carrington ND	12:02	778 US Chicago		\$3.59
Carrington to Battleford SK	11:06	620 US Moorehead MN		\$2.96
Battleford to Fort St. John	11:26	648 CA Moose Jaw SK		\$1.09
Fort St. John to Waton Lake YK	10:17	555 CA Medicine Hat AB		\$1.01
Watson Lake to Dawson YK	11:55	601 CA Mi 54 AK Hiway BC		\$1.21
Dawson to Dawson via AC	14:00	484 CA Mi 54 AK Hiway BC		\$1.21

Figure 15.2 Initial spreadsheet for the Arctic Circle road trip.

## Conditional Formatting

- Cell Value Is Specifications
  - *Format > Conditional Formatting...*
    - Change formatting in response to certain conditions
  - Can specify one or more conditions
  - Can use formulas in the comparison
    - Example: **bold** data greater than average of range

**Trip to the Arctic Circle**  
by Pat and Alex; completed 23.June.07

Segment	Time Est.	Miles	Fuel Price Report	Fuel Price
Chicago to Carrington ND	<b>12:02</b>	778 US Chicago		\$3.59
Carrington to Battleford SK	11:06	620 US Moorehead MN		\$2.96
Battleford to Fort St. John	11:26	648 CA Moose Jaw SK		\$1.09
Fort St. John to Waton Lake YK	10:17	555 CA Medicine Hat AB		\$1.01
Watson Lake to Dawson YK	11:55	601 CA Mi 54 AK Hiway BC		\$1.21
Dawson to Dawson via AC	<b>14:00</b>	484 CA Mi 54 AK Hiway BC		\$1.21

Figure 15.3 The Arctic Circle road trip spreadsheet with conditional formatting for "long days."

## Conditional Formatting (cont)

- *Formula Is* Specifications
    - Allows comparison with cells other than the one being formatted
- A2 cell: =IF(B2>AVERAGE(B\$2:B\$7), TRUE, FALSE)

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Time Est.	Miles	Fuel Price Report	Fuel Price
Chicago to Carrington ND	12:02	778 US Chicago		\$3.59
Carrington to Battleford SK	11:06	620 US Moorehead MN		\$2.96
Battleford to Fort St. John	11:26	648 CA Moose Jaw SK		\$1.09
Fort St. John to Waston Lake YK	10:17	555 CA Medicine Hat AB		\$1.01
Watson Lake to Dawson YK	11:55	601 CA Mi 54 AK Hiway BC		\$1.21
Dawson to Dawson via AC	14:00	484 CA Mi 54 AK Hiway BC		\$1.21

Figure 15.4 Conditional formatting to highlight trip Segments, whose Time Estimate is greater than average.

## Conditional Formatting (cont)

- Distinguish Between the U.S. and Canada
    - Italicize fuel cost if fuel price estimate is in Canadian dollars
- E2 cell: =IF(Left(D2,2)="CA", TRUE, FALSE)

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Time Est.	Miles	Fuel Price Report	Fuel Price
Chicago to Carrington ND	12:02	778 US Chicago		\$3.59
Carrington to Battleford SK	11:06	620 US Moorehead MN		\$2.96
Battleford to Fort St. John	11:26	648 CA Moose Jaw SK		\$1.09
Fort St. John to Waston Lake YK	10:17	555 CA Medicine Hat AB		\$1.01
Watson Lake to Dawson YK	11:55	601 CA Mi 54 AK Hiway BC		\$1.21
Dawson to Dawson via AC	14:00	484 CA Mi 54 AK Hiway BC		\$1.21

Figure 15.4 Conditional formatting to highlight trip Segments, whose Time Estimate is greater than average.

## Conditional Formulas

- Computing with conditional factors
  - Figuring the Amount Paid
    - Miles per gallon (22) vs. miles per liter (5.8)
- =IF(LEFT(D2,2)="US", E2\*C2/22, E2\*C2/5.8)

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Miles	Fuel Price Report	Fuel Price	Amount Paid
Chicago to Carrington ND	778 US Chicago		\$3.59	\$126.96
Carrington to Battleford SK	620 US Moorehead MN		\$2.96	\$83.42
Battleford to Fort St. John	648 CA Moose Jaw SK		\$1.09	\$122.23
Fort St. John to Waston Lake YK	555 CA Medicine Hat AB		\$1.01	\$96.55
Watson Lake to Dawson YK	601 CA Mi 54 AK Hiway BC		\$1.21	\$125.28
Dawson to Dawson via AC	484 CA Mi 54 AK Hiway BC		\$1.21	\$100.89

Figure 15.5 Arctic Circle spreadsheet with Amount Paid column added. Notice that Time Estimate has been hidden, and that a comment noting the assumption of 22 mpg has been added to Amount Paid heading.

## Conditional Formulas (cont)

- Cost in One Currency
    - Canadian to US currency exchange rate (0.93)
- =IF(Left(D2,2)="CA", F2\*0.93, F2)

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Miles	Fuel Price Report	Fuel Price	Amount Paid	Cost
Chicago to Carrington ND	778 US Chicago		\$3.59	\$126.96	\$126.96
Carrington to Battleford SK	620 US Moorehead MN		\$2.96	\$83.42	\$83.42
Battleford to Fort St. John BC	648 CA Moose Jaw SK		\$1.09	\$122.06	\$115.71
Fort St. John to Waston Lake YK	555 CA Medicine Hat AB		\$1.01	\$96.42	\$91.41
Watson Lake to Dawson YK	601 CA Mi 54 AK Hiway BC		\$1.21	\$125.11	\$118.60
Dawson to Watson Lake YK	601 CA Mi 54 AK Hiway BC		\$1.21	\$125.11	\$118.60
Watson Lake to Fort St. John BC	555 CA Medicine Hat AB		\$1.01	\$96.42	\$91.41
Fort St. John to Battleford SK	648 CA Moose Jaw SK		\$1.09	\$122.06	\$115.71
Battleford to Carrington ND	620 US Moorehead MN		\$2.96	\$83.42	\$83.42
Carrington to Chicago IL	778 US Chicago		\$3.59	\$126.96	\$126.96
				Total:	\$1,167.71

Figure 15.6 Arctic Circle spreadsheet completed to the point of producing an estimate for fuel costs.

## Naming: Symbolic Reference

- Defining Names

- Refer to cells *symbolically* by name rather than *literally* by explicit column/row position
- A **name** is a word or phrase assigned to a cell or range of cells (no spaces)
  - Name used wherever cell references are used
  - Minimizes errors when columns/rows added later
- In Excel 2003
  - Insert > Name > Define
  - Insert > Name > Apply
- In Excel 2007
  - Formulas tab > Define Name

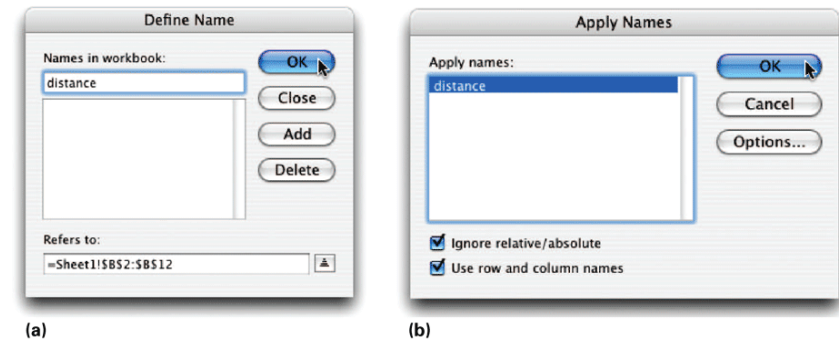


Figure 15.7 Name windows: (a) the Define Name window and (b) the Apply Names window.

## Naming: Symbolic Reference (cont)

- Applying Names

- =IF(LEFT(D2,2)="US", fuelPrice\*distance/22, fuelPrice\*distance/5.8)
- Safer, easier to read and understand

- Make Assumptions Explicit

- Assign instance-specific quantities that may change to cells, give them names, and use these names in the formulas
  - mpg, mpl, exchange rate, # of travelers
- =IF(LEFT(priceSrc,2)="US", fuelPrice\*distance/mpg, fuelPrice\*distance/mpl)

## "What If" Analysis

- Spreadsheets recalculate everything whenever a number is changed
- Ideal for speculating on the consequences of change
  - Make a change and notice what happens to the "bottom line"

## "What If" Analysis (cont)

- Direct Experimentation
  - Potential risk of making permanent changes to data and formulas
- Scenarios
  - A named alternative to a spreadsheet based on different inputs
  - Aid to understanding changes in plans, like changes in gas mileage

## Scenarios

- Tune-up Scenario
  - Excel 2003: Select mpg cell, *Tools > Scenarios...*
  - Excel 2007: *Data tab > Data Tools > What-If Analysis*

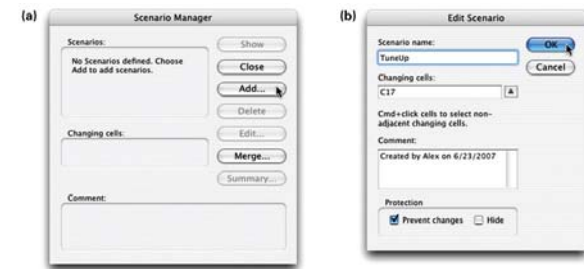


Figure 15.8 Dialog box sequence for adding a scenario to the Arctic Circle spreadsheet.

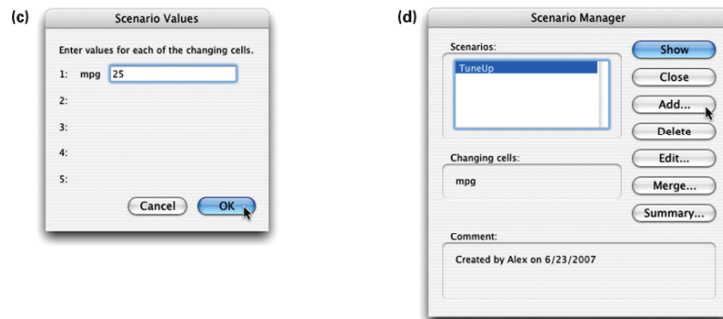


Figure 15.8 Dialog box sequence for adding a scenario to the Arctic Circle spreadsheet.

Scenario Summary		
	Current Values:	TuneUp
<b>Changing Cells:</b>		
mpg	22	25
<b>Result Cells:</b>		
FuelCost	\$1,167.71	\$1,027.59

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

Figure 15.9 The Scenario Summary sheet showing the result of the TuneUp scenario.

## Scenarios (cont)

- Traveling Companions Scenario
  - Adding buddies in the car will drop the mpg but also the cost per person

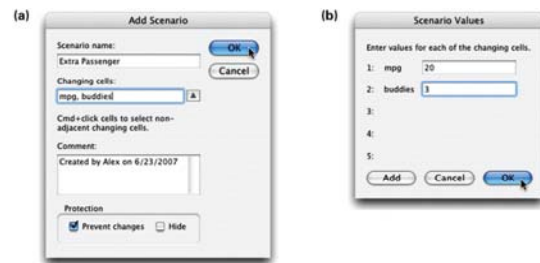


Figure 15.10 The Extra Passenger scenarios and their effect on ppFue1.

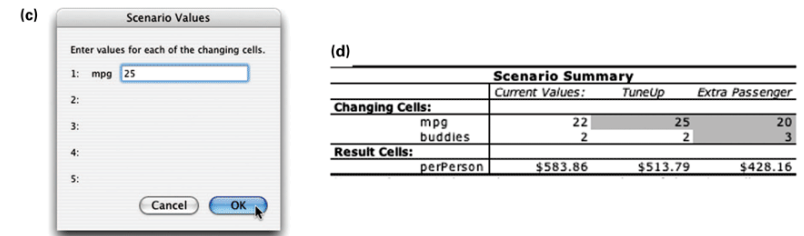


Figure 15.10 The Extra Passenger scenarios and their effect on ppFue1.

## Analyzing a Model

- Formulating a Model
  - Account for all foreseeable costs
- The Model
  - Table summarizing the per person expenses
- Reusing Scenarios
  - Rerun scenarios to see how the total cost changes as the number of travelers increases

**Trip to the Arctic Circle**  
by Pat and Alex; completed 23.June.07

Lodging	Occupancy	Price	Lodging Expense	Contingencies	Just In Case
Campground	2	25	25	Base Cost	\$100.00
Provincial Park	2	20	20	Tires	\$160.00
Provincial Park	2	20	20		
Wilderness	2	0	0		
Hostel@20	1	20	40		
Hostel@20	1	20	40		
Wilderness	2	0	0		
Provincial Park	2	20	20		
Provincial Park	2	20	20		
Campground	2	25	25		
Total			\$210.00		\$260.00
Total Per Person			\$105.00		\$130.00
Camping	Yes				

Figure 15.11 The lodging and contingency data for the Arctic Circle road trip.

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Costs	Amount Per Person
Fuel	\$583.86
Lodging	\$105.00
Contingency	\$130.00
Total	\$818.86

Scenario Summary			
	Current Values:	1 Extra Traveler	2 Extra Travelers
<b>Changing Cells:</b>			
mpg	22	21	20
buddies	2	3	4
<b>Result Cells:</b>			
estTotal	\$818.86	\$599.44	\$491.12

## Analyzing a Model

- A Change in Plans
  - Stay in Hostels vs. camping

Scenario Summary				
	Current Values:	1 Extra Traveler	2 Extra Travelers	Hostel Upgrade
<b>Changing Cells:</b>				
mpg	22	21	20	20
buddies	2	3	4	4
\$J\$2	25	25	25	18
\$J\$3	20	20	20	18
\$J\$4	20	20	20	18
\$J\$5	0	0	0	18
\$J\$6	20	20	20	18
\$J\$7	20	20	20	18
\$J\$8	0	0	0	18
\$J\$9	20	20	20	18
\$J\$10	20	20	20	18
\$J\$11	25	25	25	18
camping	Yes	Yes	Yes	No
<b>Result Cells:</b>				
estTotal	\$818.86	\$577.77	\$458.62	\$566.12

Figure 15.12 Scenario Summary table for the Arctic Circle road trip.

## Analyzing Data Using Filtering

- Travel Log spreadsheet
  - Can use a *filter* to access subsets of information (selecting only certain rows from a list) to create a customized version of a spreadsheet
- Auto Filtering Technique
  - Data > Filter > AutoFilter
  - Options for filtering the list based on data in each column
  - Turn off AutoFilter by selecting it again (toggle)

### Road To Arctic Circle and Back: Stops

Pat, Alex, Chi, Ali

When	Seg. No	Where	Reason	Buy	\$	Amt	MI	Remark
8/4/07 5:45	1	All's house IL	Last pick-up			0.00		We're Off!
8/4/07 6:40	1	Toll Booth IL	Alex Fumbles	All tolls	X	2.85		
8/4/07 8:05	1	DriveThru Joe IL	Espresso					Only driver
8/4/07 9:00	1	Beloit WI	Gas & Go	Gas	A	34.50	241	
8/4/07 9:55	1	Madison WI	Snacks					
8/4/07 12:05	1	St. Paul MN	Gas & Go, Eat	Gas	P	28.95	191	Subway
8/4/07 14:45	1	St. Cloud MN	Stretch/Photo					Pretty Here
8/4/07 15:30	1	Sauk Center MN	Snacks					
8/4/07 16:55	1	Fergus Falls MN	Gas & Go	Gas	P	29.22	205	
8/4/07 19:45	1	Fargo ND	Photo in ND					Pat's First
8/4/07 20:25	1	Valley City ND	Supper					Junk Food
8/4/07 22:00	1	Carrington ND	Stay Night	Camp	C	21.45		Great Start
8/5/07 7:25	2	Carrington ND	Gas	Gas	A	37.42	252	
8/5/07 7:55	2	Sykeston ND	Photo					Its flat
8/5/07 10:05	2	Minot ND	Gas & Go, Snx	Gas	X	19.64	135	Ice Cream
8/5/07 11:50	2	Portal ND	Photo in CA					Ali, Pat, 1st
8/5/07 12:25	2	Estevan SK	Lunch					
8/5/07 13:55	2	Weyburn SK	Gas & Go, Eat	Gas	A	33.82	151	
8/5/07 15:45	2	Moose Jaw SK	Snacks					I Scream!

Figure 15.13 Start of the Travel Log of the Arctic Circle road trip. Seg. No corresponds to a segment of the original plan (Sheet 1). \$ refers to who paid a shared expense. MI is distance traveled since last fuel.

## Advanced Filtering Technique

- More refined analysis with precise filtering criteria
- Advanced Filtering Setup
  - Add a new column with the *same heading* as the column containing the date to be filtered
  - Enter a criterion to indicate that values in the other column by the same name should be filtered with that criterion

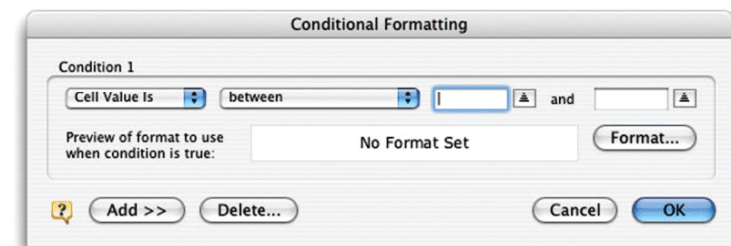
## Advanced Filtering Technique (cont)

- Executing an Advanced Filter
  - Select a cell in the column to be filtered
  - *Data > Filtering > Advanced Search...*
    - *List range*: dimension of the list to be filtered
    - *Criteria range*: range covering the heading and the criterion of setup column
    - *Copy to*: specifies a new place on the spreadsheet to place the filtered result (optional)
  - Restore original table: *Data > Filtering > Show All*

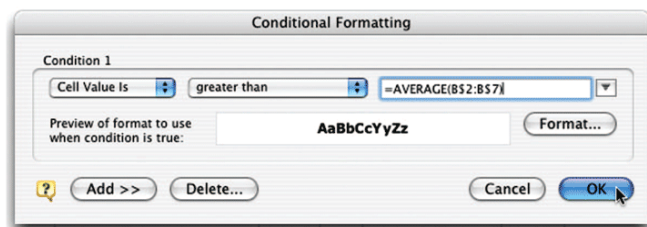
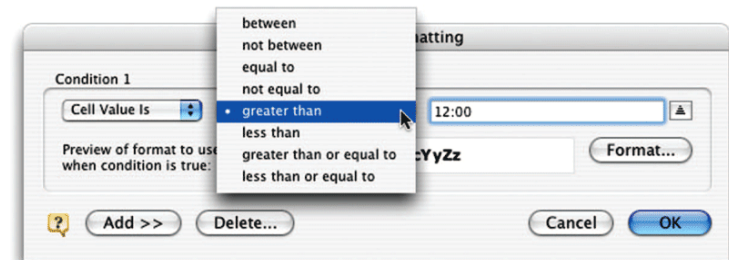
## Advanced Filtering Technique (cont)

- Filtering on Multiple Criteria
  - Define multiple setup columns with criteria
  - *Criteria range* in Advanced Filter window is enlarged to cover all criteria in the setup columns

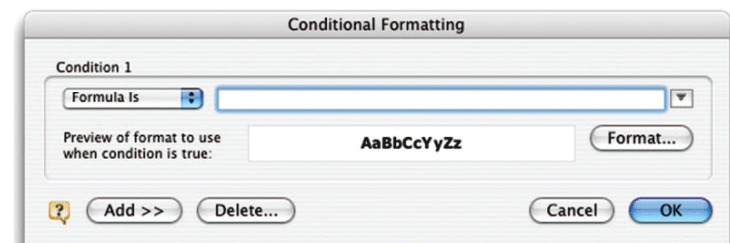
Chicago to Carrington, ND:	778 miles,	12 hrs, 2 minutes
Carrington to Battleford, SK:	620 miles,	11 hrs, 6 minutes
Battleford to Fort St. John, BC:	648 miles,	11 hrs, 26 minutes
Fort St. John to Watson Lake, BC:	555 miles,	10 hrs, 17 minutes
Watson Lake to Dawson, YK:	601 miles,	11 hrs, 55 minutes
Round-trip Dawson to Arctic Circle:	484 miles,	14 hours

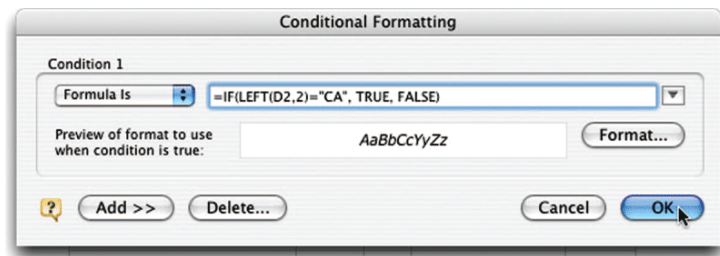


Alex: Prices from gasbuddy.com		Fuel Price
778 US Chicago		\$3.59
620 US Moorehead MN		\$2.96

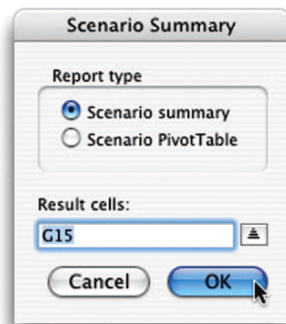


Time Est.
12:02
11:06
11:26
10:17
11:55
14:00





<b>Assumptions:</b>	
Miles per gallon:	22
Miles per liter:	5.81
US-Canadian Exchange Rate:	0.948
Travlers:	2



<b>Total:</b>	<b>\$1,167.71</b>
<b>Cost Each</b>	<b>\$583.86</b>

### Scenario Summary

Report type

☒ Scenario summary  
☐ Scenario PivotTable

Result cells:

estTotal

Total			\$210.00
Total Per Person			\$105.00
Camping	Yes		

Seg.									
When	N	Where	Reason	Buy	Amt	M	Remark		
8/4/07 5:45	1	Ali's house IL	Last pick-up		0.00				
8/4/07 6:40	1	Toll Booth IL	Alex Fumbles	All tolls	2.85	X			

Seg.									
When	N	Where	Reason	Buy	Amt	M	Remark		
8/4/07 5:45	1	Ali's house IL	Last pick-up		0.00				
8/4/07 6:40	1	Toll Booth IL	Alex Fumbles	All tolls	2.85	X			

Reason	Buy	Amt
Last pick-up	Sort Ascending	1.00
Alex Fumbles	Sort Descending	1.85
Espresso	✓ (Show All)	
Gas & Go	(Show Top 10...)	1.50
Snacks	(Custom Filter...)	
Gas & Go, Eat	All tolls	1.95
Stretch/Photo	Camp	
Snacks	✓ (Show Blank)	1.22
Gas & Go	(Show NonBlank)	
Photo in ND		

**Road To Arctic Circle and Back: Stops**  
Pat, Alex, Chi, Ali

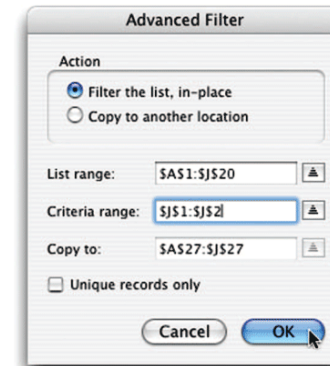
Seg.									
When	N	Where	Reason	Buy	Amt	M	Remark		
8/4/07 9:00	1	Belot WI	Gas & Go	Gas	34.50	241			
8/4/07 12:05	1	St. Paul MN	Gas & Go, Eat	Gas	28.95	191	Subway		
8/4/07 16:55	1	Fergus Falls MN	Gas & Go	Gas	29.22	205			
8/5/07 7:25	2	Carrington ND	Gas	Gas	37.42	252			
8/5/07 10:05	2	Minot ND	Gas & Go, Snx	Gas	19.64	135	Ice Cream		
8/5/07 13:55	2	Weyburn SK	Gas & Go, Eat	Gas	33.82	151			

Buy	Amt	M
Gas	Sort Ascending	41
Gas	Sort Descending	91
Gas	✓ (Show All)	05
Gas	(Show Top 10...)	52
Gas	(Custom Filter...)	35
Gas	A	51
Gas	P	
Gas	X	

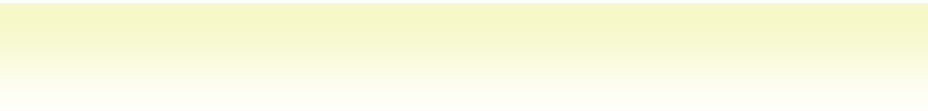
Seg.									
When	N	Where	Reason	Buy	Amt	M	Remark		
8/5/07 10:05	2	Minot ND	Gas & Go, Snx	Gas	19.64	135	Ice Cream		

When	Seg. No	Where	Reason	Buy	\$	Amt	Mi	Mi
8/4/07 5:45	1	All's house IL	Last pick-up			0.00		>175
8/4/07 6:40	1	Toll Booth IL	Alex Fumbles	All tolls	X	2.85		



When	Seg. No	Where	Reason	Buy	\$	Amt	Mi	Mi
8/4/07 9:00	1	Beloit WI	Gas & Go	Gas	A	34.50	241	
8/4/07 12:05	1	St. Paul MN	Gas & Go, Eat	Gas	P	28.95	191	
8/4/07 16:55	1	Fergus Falls MN	Gas & Go	Gas	P	29.22	205	
8/5/07 7:25	2	Carrington ND	Gas	Gas	A	37.42	252	

When	Seg. No	Where	Reason	Buy	\$	Amt	Mi	Mi	Mi
8/4/07 5:45	1	All's house IL	Last pick-up			0.00		>175	<225



When	Seg. No	Where	Reason	Buy	\$	Amt	Mi	Mi	Mi
8/4/07 12:05	1	St. Paul MN	Gas & Go, Eat	Gas	P	28.95	191		
8/4/07 16:55	1	Fergus Falls MN	Gas & Go	Gas	P	29.22	205		