Graphic User Interfaces and Validation

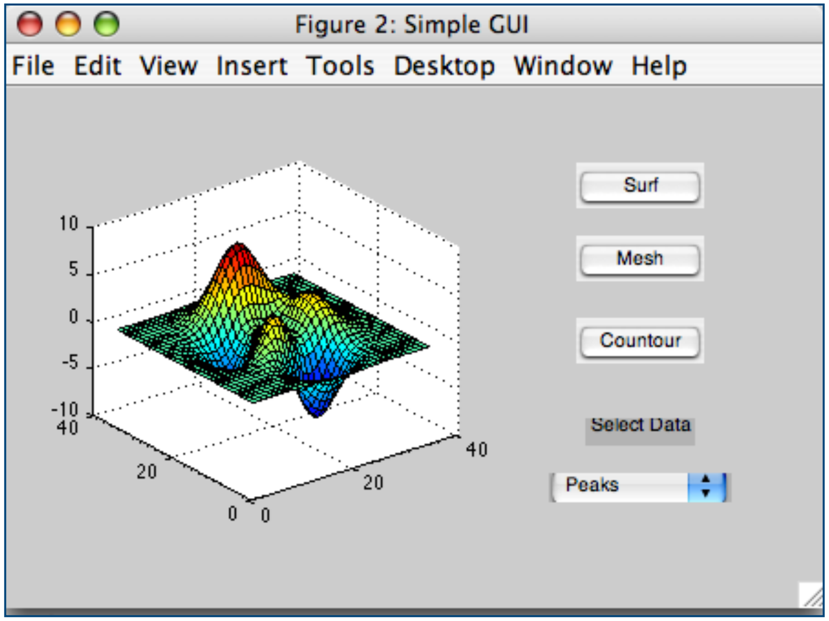
CEE3804: Computer Applications for Civil and Environmental Engineers

Objectives

- Apply good principles of data validation in spreadsheets
- Understand the principles of Graphic User Interfaces (GUI)
- Provide some examples to understand simple GUIs

Why Graphic User Interfaces?

- Promotes better use of your programs by non-technical users or by your own colleagues
- Users do not have to be familiar with every line of code in VBA or Matlab to use your program
- GUIs can present only relevant information to a user



Sample GUI
Source: Mathworks

Techniques to Provide Ease of Use

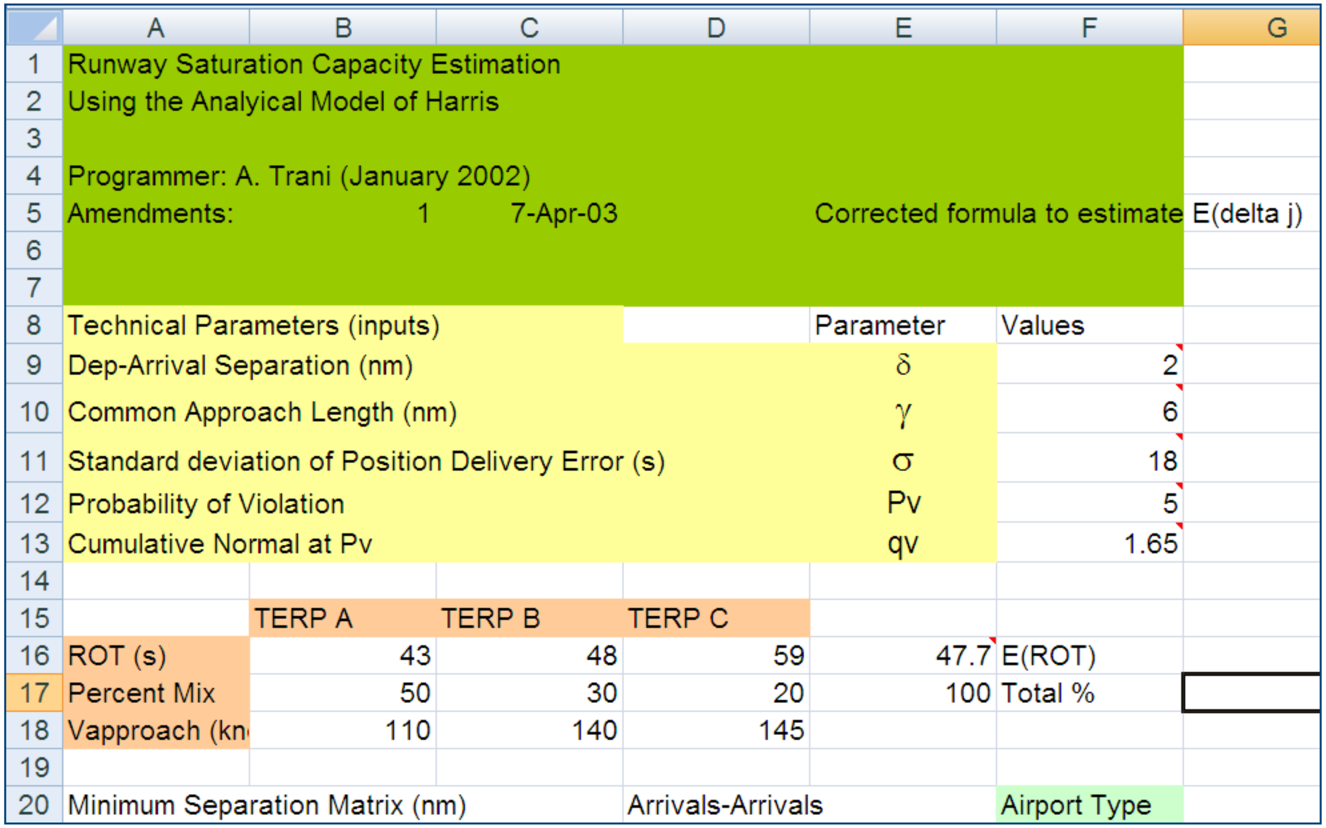
- In VBA
  - Color code and data validation/entry
  - Types of controls
    - User Form controls
    - ActiveX controls
- In Matlab
  - Command window input queries
  - Use Matlab Graphic User Interface maker

VBA Techniques (Data Validation)

- A regular spreadsheet can direct a user to vary certain number of parameters in the program
- Use color coding and data validation

Runway_capacity.xls

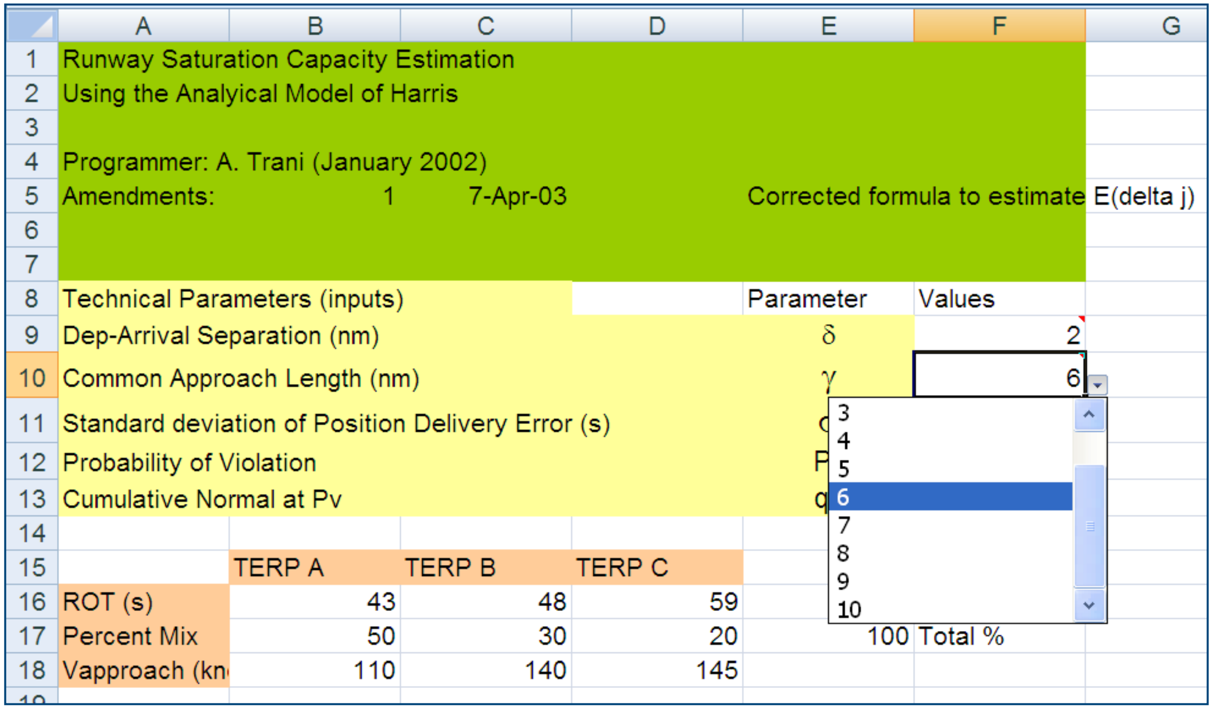
File on the web server



	A	B	C	D	E	F	G
1	Runway Saturation Capacity Estimation						
2	Using the Analyical Model of Harris						
3							
4	Programmer: A. Trani (January 2002)						
5	Amendments:	1	7-Apr-03		Corrected formula to estimate		E(delta j)
6							
7							
8	Technical Parameters (inputs)				Parameter	Values	
9	Dep-Arrival Separation (nm)				δ	2	
10	Common Approach Length (nm)				γ	6	
11	Standard deviation of Position Delivery Error (s)				σ	18	
12	Probability of Violation				Pv	5	
13	Cumulative Normal at Pv				qv	1.65	
14							
15		TERP A	TERP B	TERP C			
16	ROT (s)	43	48	59	47.7	E(ROT)	
17	Percent Mix	50	30	20	100	Total %	
18	Vapproach (kn	110	140	145			
19							
20	Minimum Separation Matrix (nm)			Arrivals-Arrivals		Airport Type	

VBA Techniques (Data Validation)

- This program allows certain inputs to the user from a list of inputs (check the Common Approach Length parameter - Gamma)
- This reduces possible data entry errors

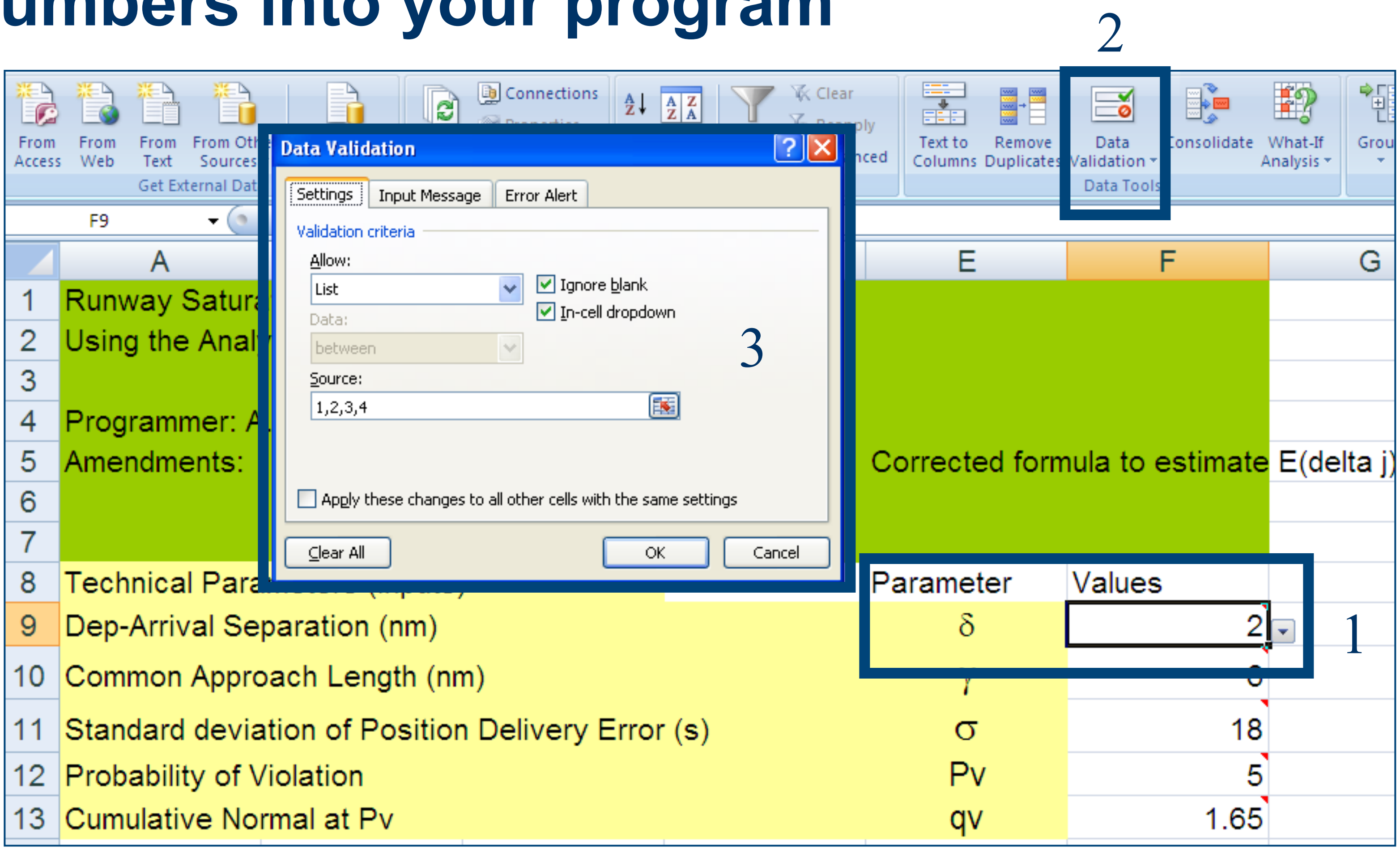


	A	B	C	D	E	F	G
1	Runway Saturation Capacity Estimation						
2	Using the Analyical Model of Harris						
3							
4	Programmer: A. Trani (January 2002)						
5	Amendments:	1	7-Apr-03		Corrected formula to estimate E(delta j)		
6							
7							
8	Technical Parameters (inputs)				Parameter	Values	
9	Dep-Arrival Separation (nm)				δ	2	
10	Common Approach Length (nm)				γ	6	
11	Standard deviation of Position Delivery Error (s)				c		
12	Probability of Violation				P		
13	Cumulative Normal at Pv				q		
14							
15		TERP A	TERP B	TERP C			
16	ROT (s)	43	48	59			
17	Percent Mix	50	30	20	100	Total %	
18	Vapproach (kn	110	140	145			

3
4
5
6
7
8
9
10

VBA Data Validation

- **Use the Data validation to limit the entry of numbers into your program**



Data Validation

Settings | Input Message | Error Alert

Validation criteria

Allow: List

☑ Ignore blank

☑ In-cell dropdown

Data: between

Source: 1,2,3,4

☐ Apply these changes to all other cells with the same settings

Clear All | OK | Cancel

	A	E	F	G
1	Runway Satura			
2	Using the Anal			
3				
4	Programmer: A			
5	Amendments:	Corrected formula to estimate		E(delta j)
6				
7				
8	Technical Para	Parameter	Values	
9	Dep-Arrival Separation (nm)	δ	2	
10	Common Approach Length (nm)	γ	6	
11	Standard deviation of Position Delivery Error (s)	σ	18	
12	Probability of Violation	Pv	5	
13	Cumulative Normal at Pv	qv	1.65	

Why is Data Validation Important?

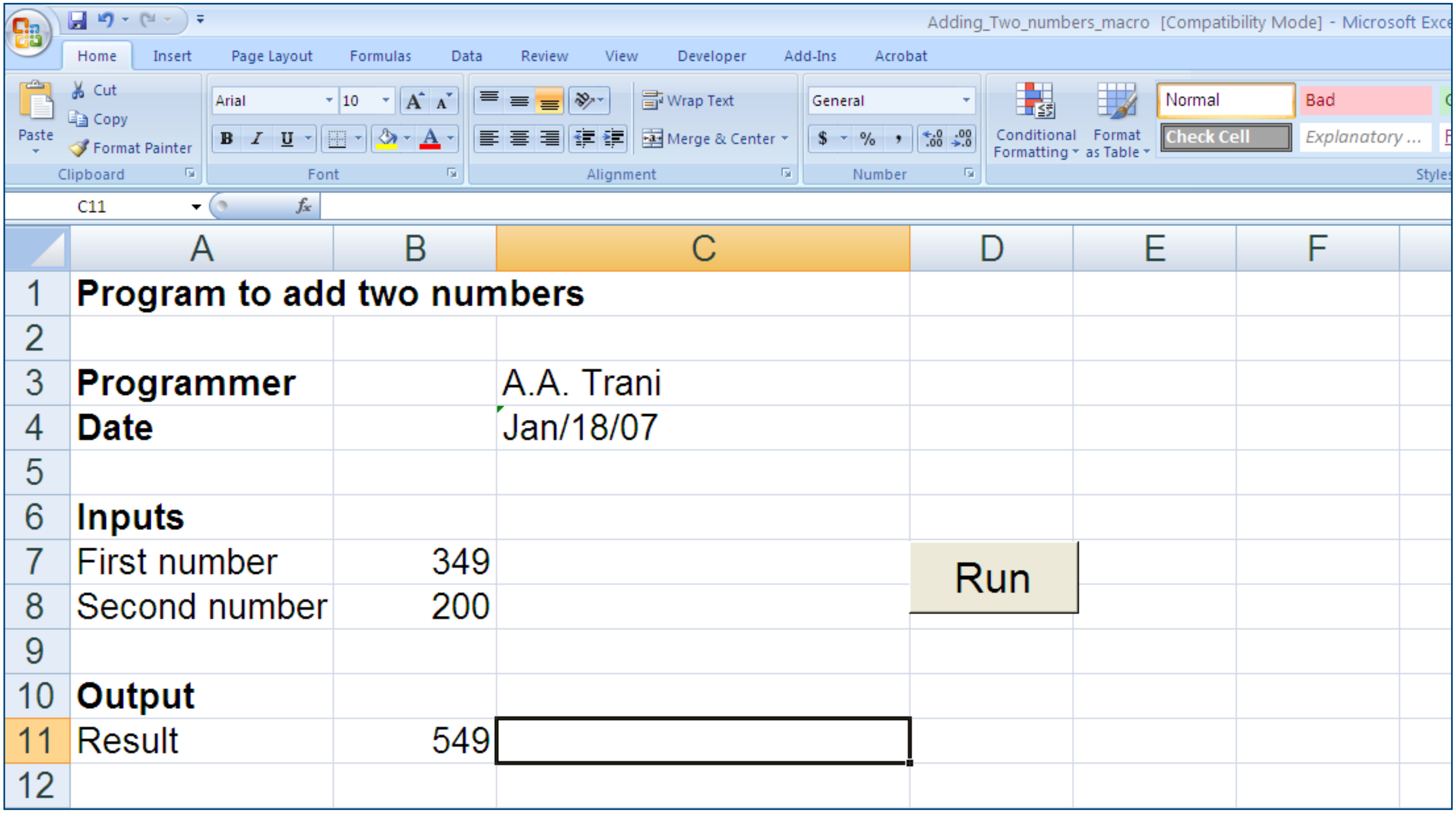
- Reduces costly (in design and economics) entry data errors
- Simplifies the use of the Excel spreadsheet
- Make the program more “professional” looking

- Add comments to the spreadsheet to communicate the steps in the calculations if possible
- Adding a comments goes a long way to explain your spreadsheet to others

VBA Adding Simple Controls

- Two types of controls in VBA
- ActiveX
  - Simpler to use
  - Good for quick prototyping
- Form Controls
  - Require more information (code)
  - Better looking
  - More powerful

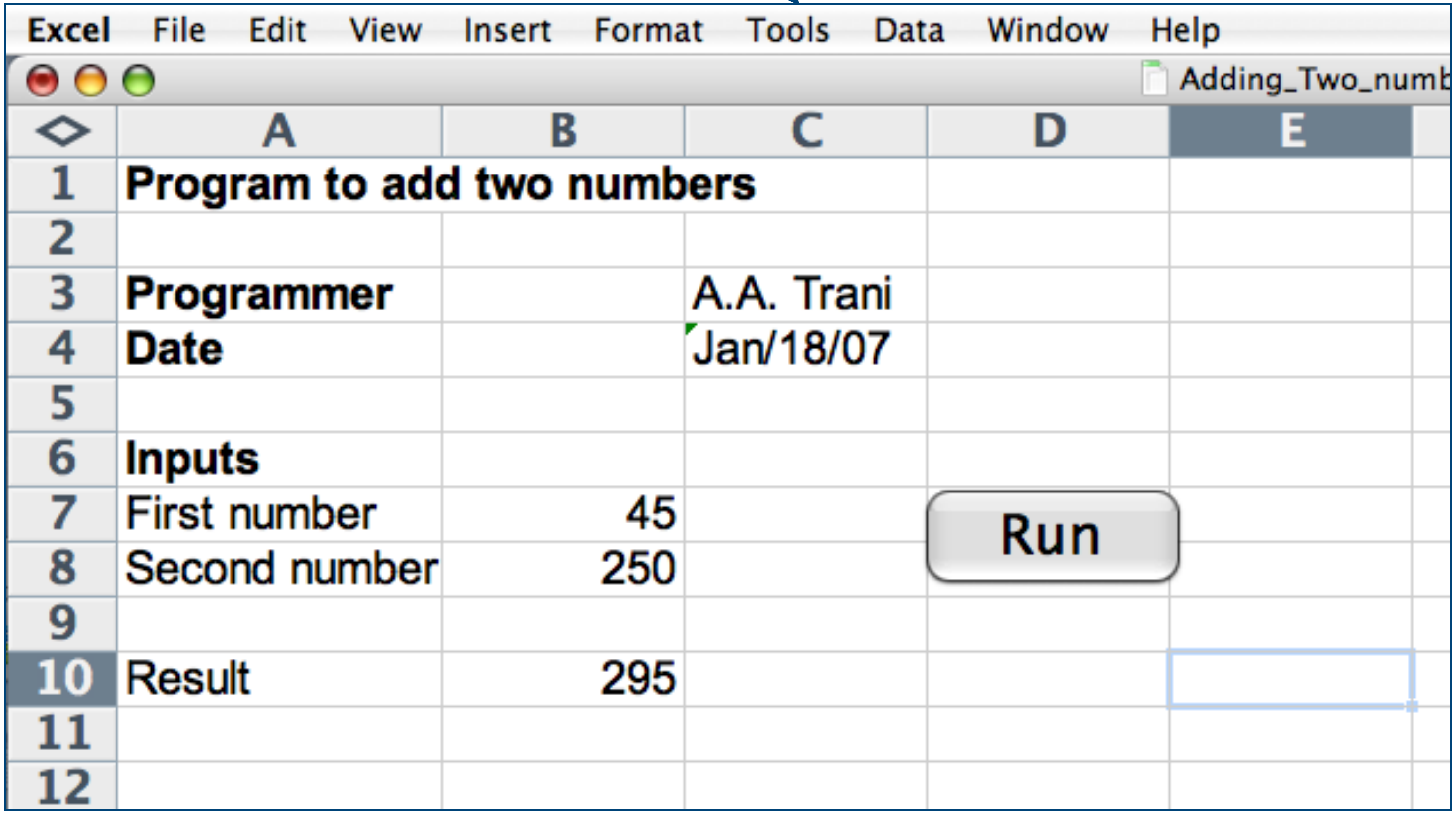
Excel Worksheet (final program)



	A	B	C	D	E	F
1	**Program to add two numbers**					
2						
3	**Programmer**		A.A. Trani			
4	**Date**		Jan/18/07			
5						
6	**Inputs**					
7	First number	349				
8	Second number	200				
9						
10	**Output**					
11	Result	549				
12						

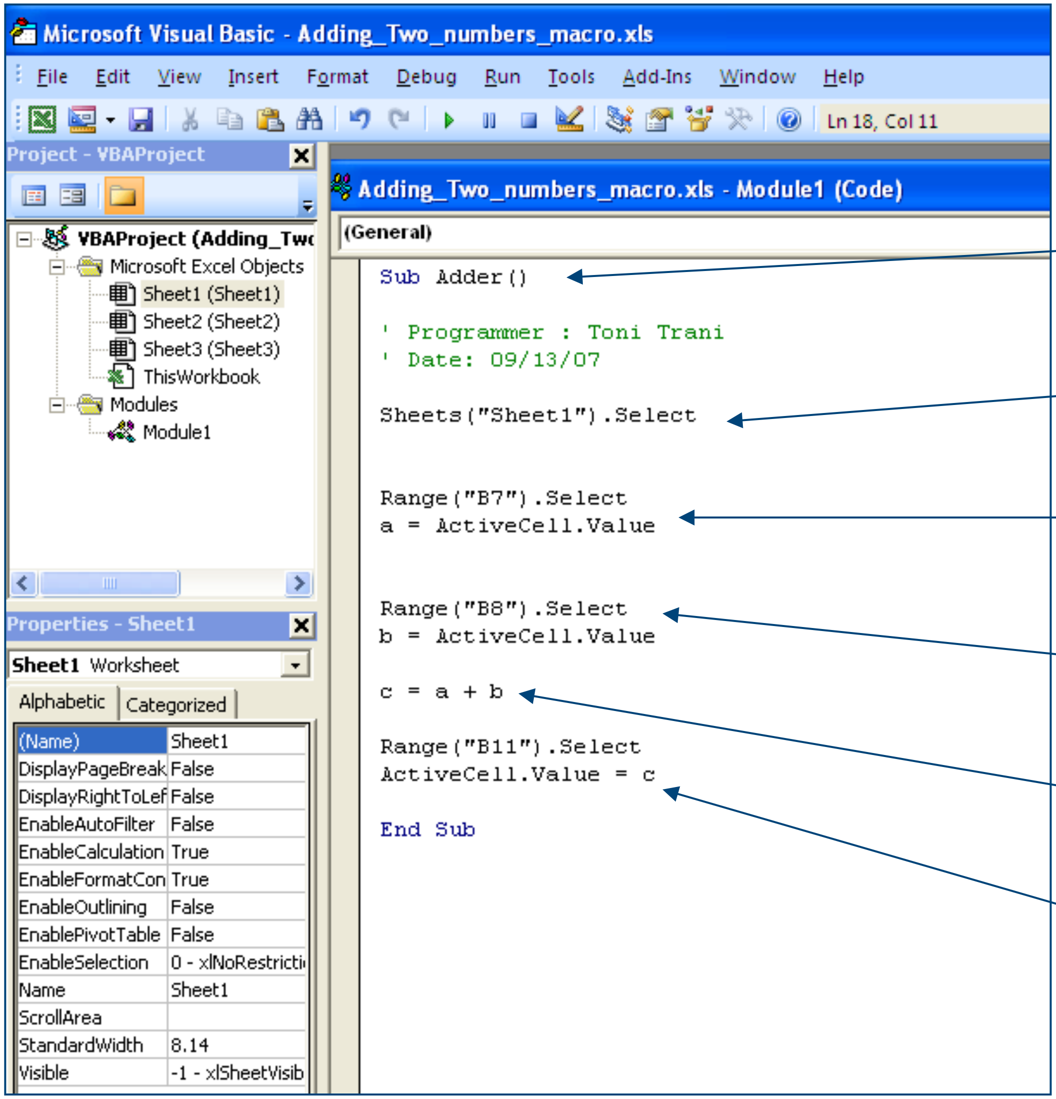
VBA or Macros in Excel

- Go to: Tools/Macro
- Then select VBA



	A	B	C	D	E
1	**Program to add two numbers**				
2					
3	**Programmer**		A.A. Trani		
4	**Date**		Jan/18/07		
5					
6	**Inputs**				
7	First number	45			
8	Second number	250			
9					
10	Result	295			
11					
12					

VBA Code



(Name)	Sheet1
DisplayPageBreak	False
DisplayRightToLef	False
EnableAutoFilter	False
EnableCalculation	True
EnableFormatCon	True
EnableOutlining	False
EnablePivotTable	False
EnableSelection	0 - xlNoRestricti
Name	Sheet1
ScrollArea	
StandardWidth	8.14
Visible	-1 - xlSheetVisib

```
Sub Adder()

' Programmer : Toni Trani
' Date: 09/13/07

Sheets("Sheet1").Select


Range("B7").Select
a = ActiveCell.Value


Range("B8").Select
b = ActiveCell.Value

c = a + b

Range("B11").Select
ActiveCell.Value = c

End Sub
```

Name of subroutine

Go to “sheet1”

Select the value of cell B7 and assign it to variable “a”

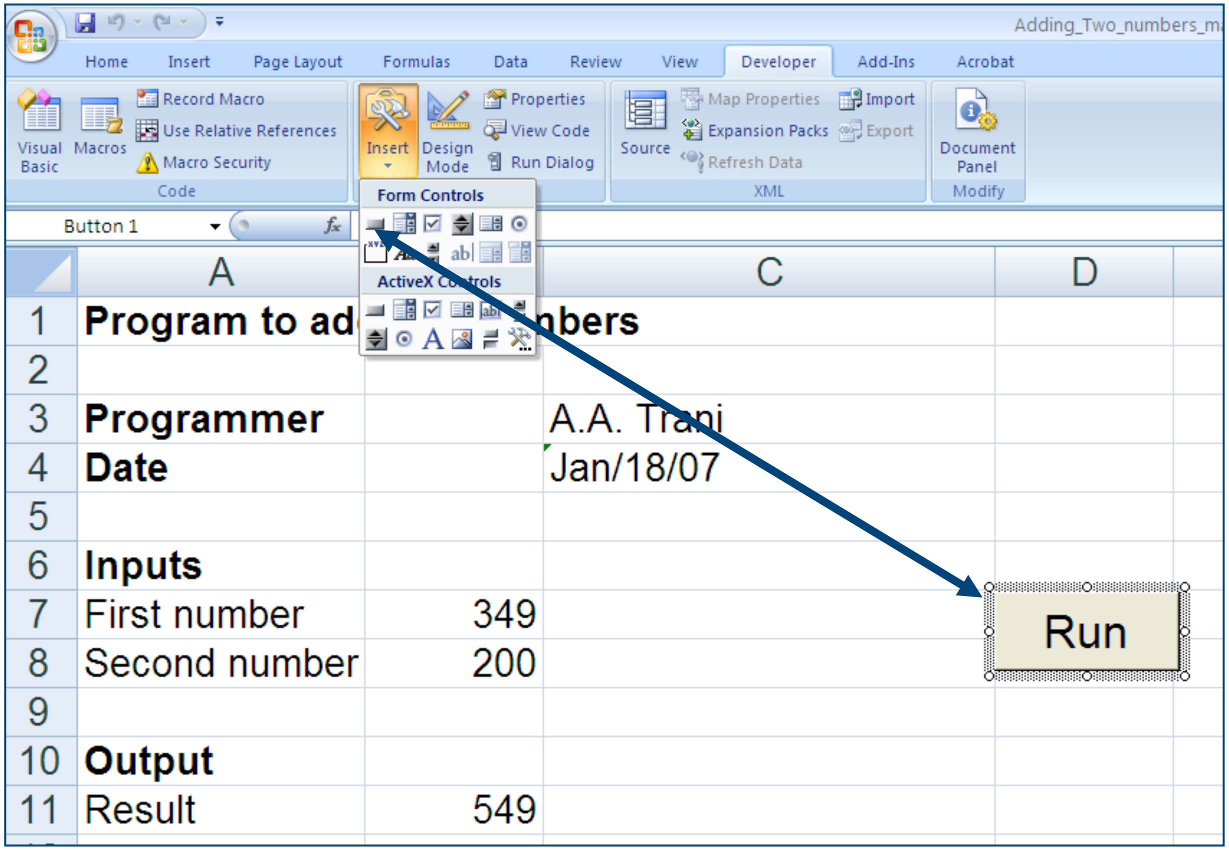
Select the value of cell B8 and assign it to variable “b”

Calculate the value of “c”

Select cell B8 and assign it to variable “c”

Adding the “Run” Button

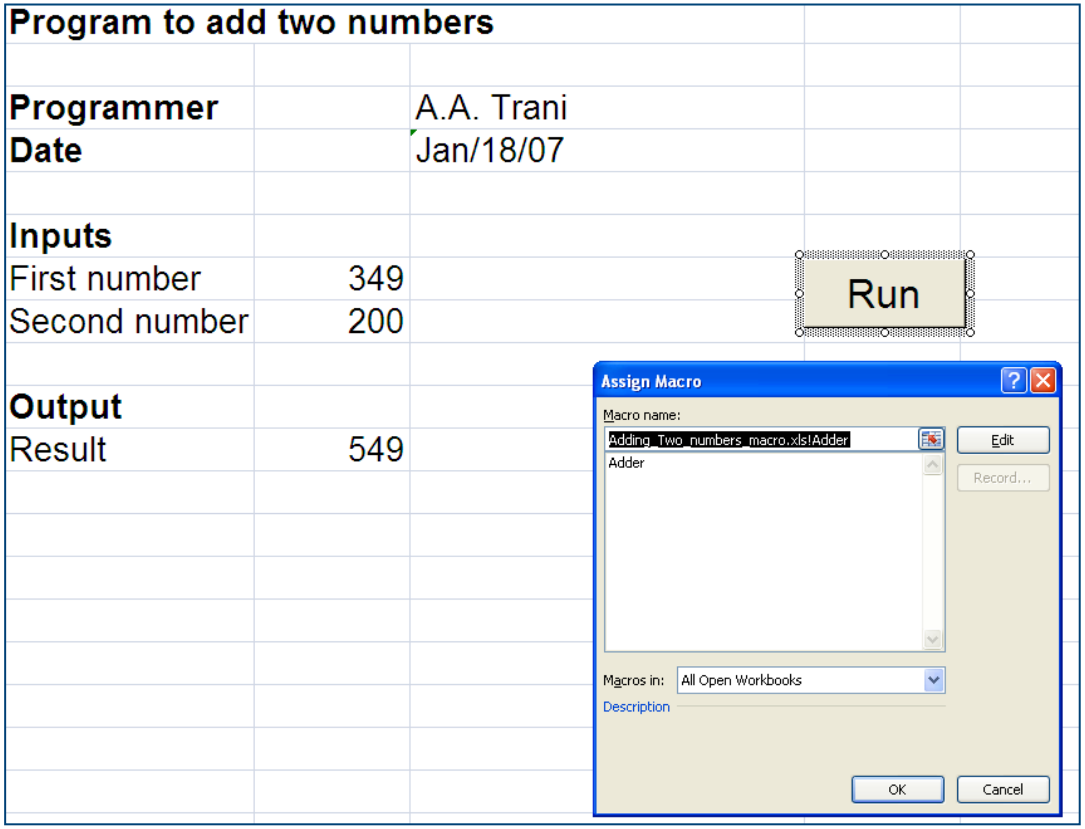
- Adding the “run” button requires that you insert a control button and then assign a macro to subroutine “adder”



	A	B	C	D
1	**Program to ad**		**nbers**	
2				
3	**Programmer**		A.A. Trani	
4	**Date**		Jan/18/07	
5				
6	**Inputs**			
7	First number	349		
8	Second number	200		
9				
10	**Output**			
11	Result	549		

Assigning the Behavior to the “Run” Button

- Assign the macro “adder” from the list of available macros to button “Run”
- Right-click on the button to assign a behavior



Program to add two numbers

Programmer	A.A. Trani
Date	Jan/18/07

Inputs

First number	349
Second number	200

Output

Result	549

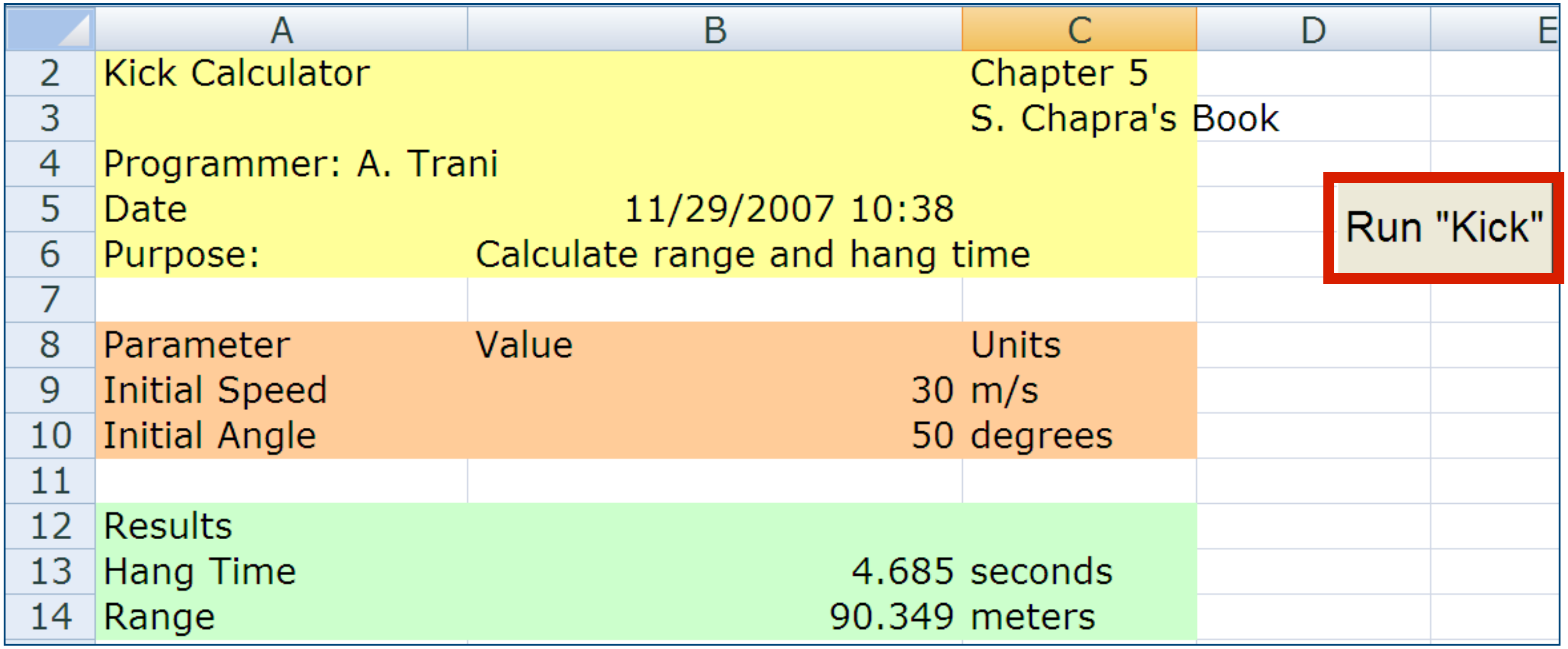
Macro name: Adding_Two_numbers_macro.xls!Adder

Adder

Macros in: All Open Workbooks

Previous Example (kicker_with_angleTable_2003.xls)

- **Kicker program with “Run” button assigned to a macro**



	A	B	C	D	E
2	Kick Calculator		Chapter 5		
3			S. Chapra's Book		
4	Programmer: A. Trani				
5	Date	11/29/2007 10:38			
6	Purpose:	Calculate range and hang time			
7					
8	Parameter	Value	Units		
9	Initial Speed	30	m/s		
10	Initial Angle	50	degrees		
11					
12	Results				
13	Hang Time	4.685	seconds		
14	Range	90.349	meters		

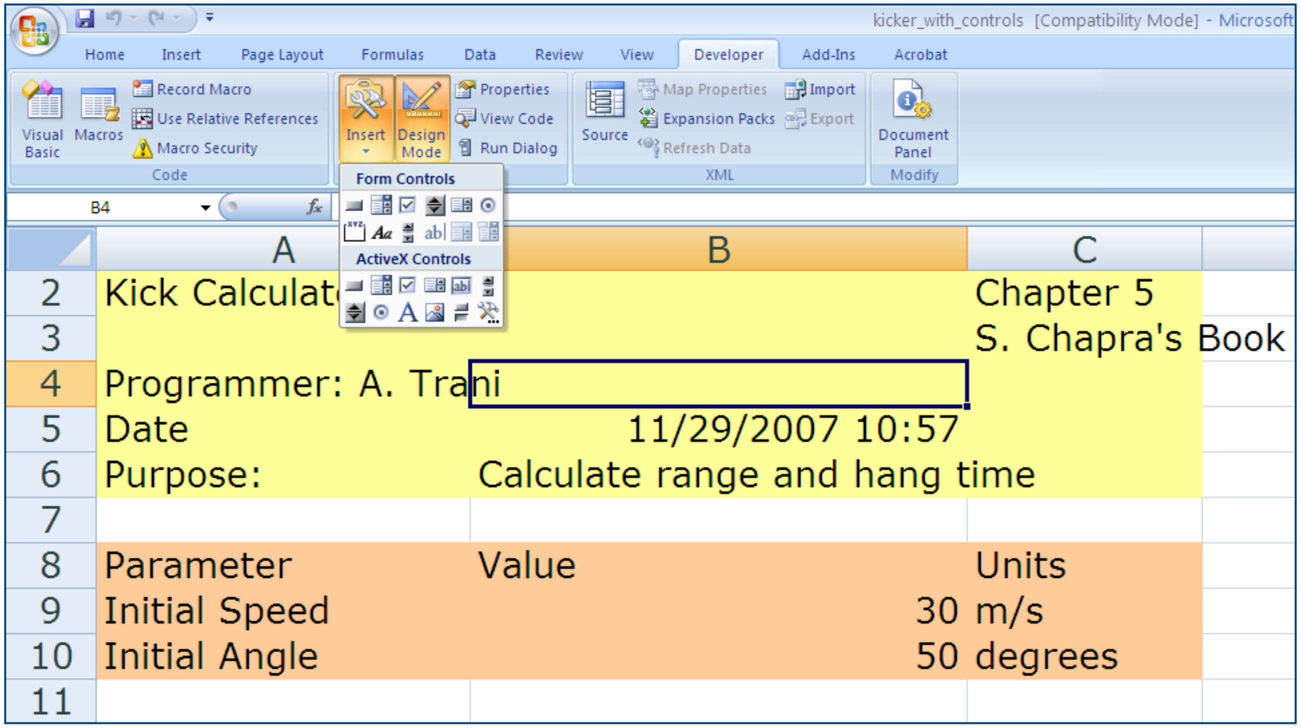
Suppose We Add a New Control

- Lets add a slider control to set the values of initial angle and initial speed in this program

- Procedure:
- Go to the “Developer” tab in Excel
- Go to the “View” toolbox (then forms) in older versions of Excel

Adding a New Control (Form Control)

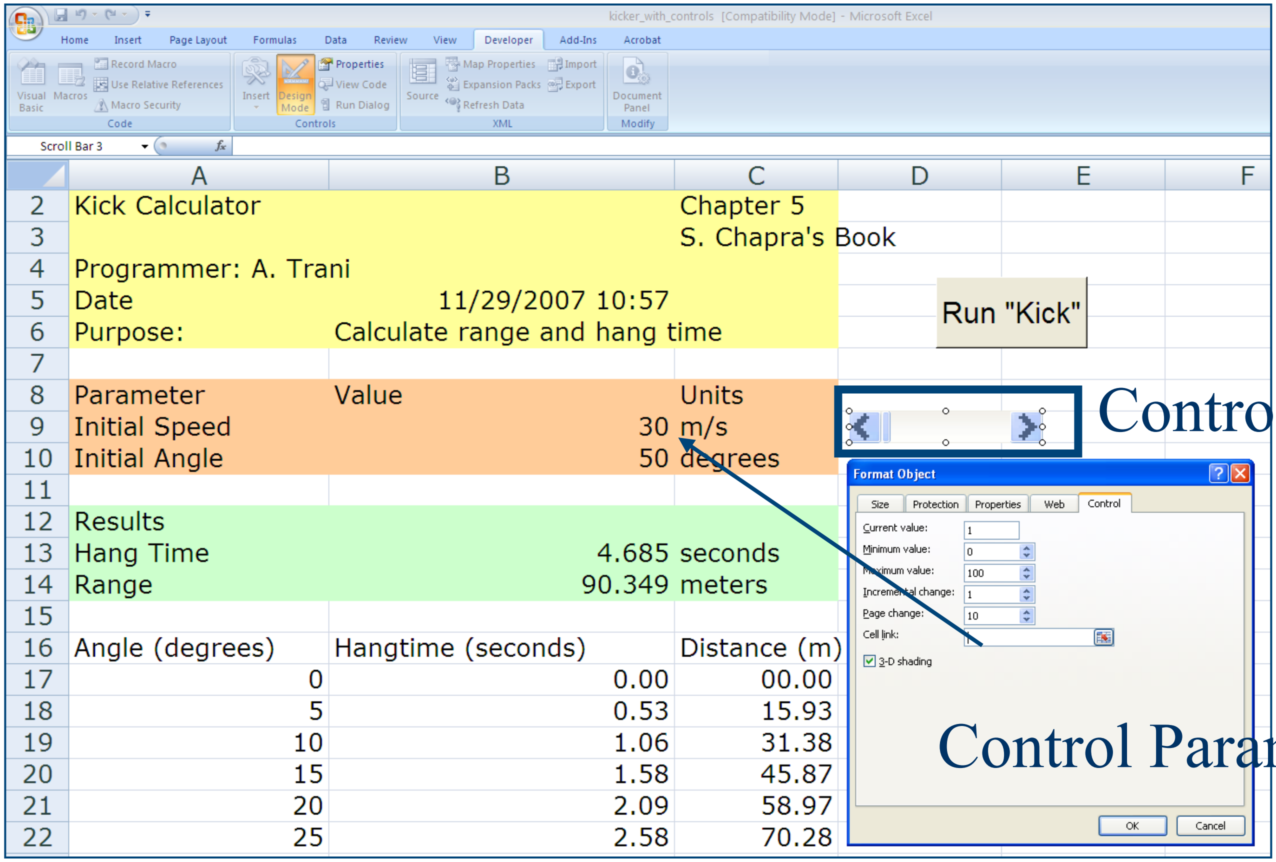
- Check all controls available and add a simple scrollbar control to the “kicker” spreadsheet



	A	B	C
2	Kick Calculat		Chapter 5
3			S. Chapra's Book
4	Programmer: A. Trani		
5	Date	11/29/2007 10:57	
6	Purpose:	Calculate range and hang time	
7			
8	Parameter	Value	Units
9	Initial Speed	30	m/s
10	Initial Angle	50	degrees
11			

VBA Control Example

- The Control is linked to a cell in your spreadsheet



	A	B	C	D	E	F
2	Kick Calculator		Chapter 5			
3			S. Chapra's Book			
4	Programmer: A. Trani					
5	Date	11/29/2007 10:57				
6	Purpose:	Calculate range and hang time				
7						
8	Parameter	Value	Units			
9	Initial Speed	30	m/s			
10	Initial Angle	50	degrees			
11						
12	Results					
13	Hang Time	4.685	seconds			
14	Range	90.349	meters			
15						
16	Angle (degrees)	Hangtime (seconds)	Distance (m)			
17	0	0.00	00.00			
18	5	0.53	15.93			
19	10	1.06	31.38			
20	15	1.58	45.87			
21	20	2.09	58.97			
22	25	2.58	70.28			

Current value: 1

Minimum value: 0

Maximum value: 100

Incremental change: 1

Page change: 10

Cell link:

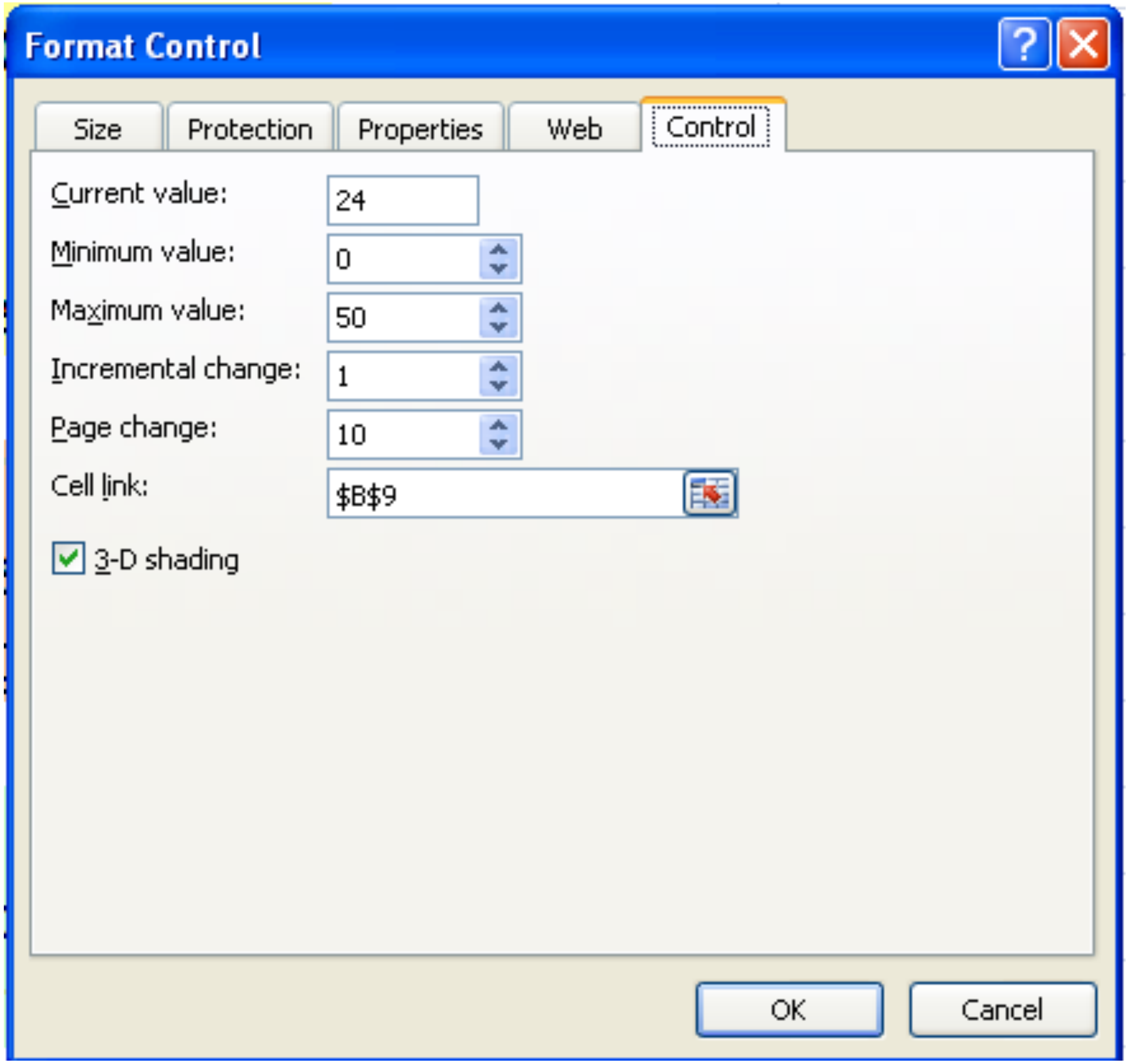
☑ 3-D shading

Control (scrollbar)

Control Parameters

VBA Controls : Specify the Parameters of the Control

- Enter the values of the control
- Link the control to a cell (or cells) in your spreadsheet



Format Control

Current value: 24

Minimum value: 0

Maximum value: 50

Incremental change: 1

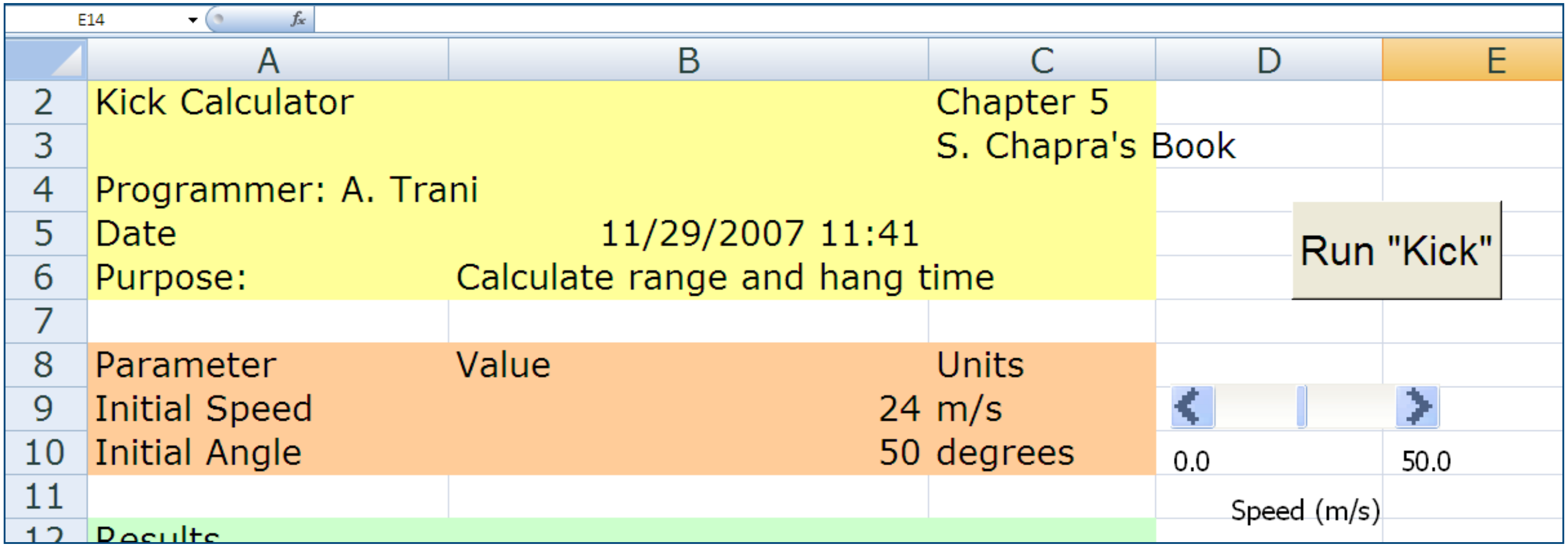
Page change: 10

Cell link: B9

☑ 3-D shading

Add Other Controls to Ease Use of the Spreadsheet

- Add text controls to specify the range of your control to the user
- In this case I added 3 text controls as labels

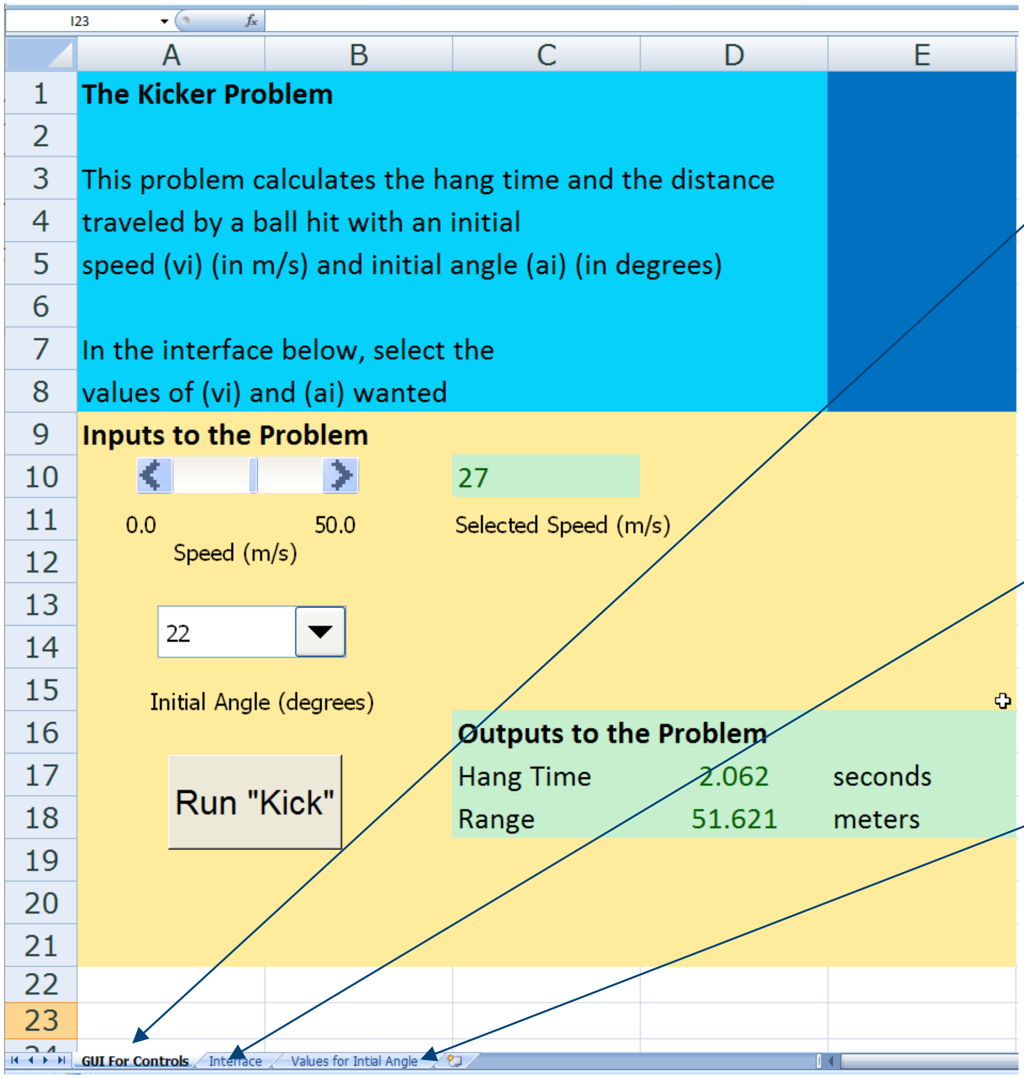


	A	B	C	D	E
2	Kick Calculator		Chapter 5		
3			S. Chapra's Book		
4	Programmer: A. Trani				
5	Date	11/29/2007 11:41			
6	Purpose:	Calculate range and hang time			
7					
8	Parameter	Value	Units		
9	Initial Speed	24	m/s		
10	Initial Angle	50	degrees	0.0	50.0
11				Speed (m/s)	
12	Results				

Adding a New Worksheet as GUI (Graphic User Interface)

- Lets add a new worksheet that acts as Graphic User Interface
- Lets add information about the problem
- Lets add a new control (a combo box) to control the initial angle (ai)
- The values of the controls should be stated in the GUI interface
- Lets add a new worksheet that contains the values of the combo box for initial angle

Final GUI for Kicker Problem



The Kicker Problem

This problem calculates the hang time and the distance traveled by a ball hit with an initial speed (vi) (in m/s) and initial angle (ai) (in degrees)

In the interface below, select the values of (vi) and (ai) wanted

Inputs to the Problem

27

Selected Speed (m/s)

0.0 50.0

Speed (m/s)

22

Initial Angle (degrees)

Outputs to the Problem

Hang Time	2.062	seconds
Range	51.621	meters

Added Worksheet

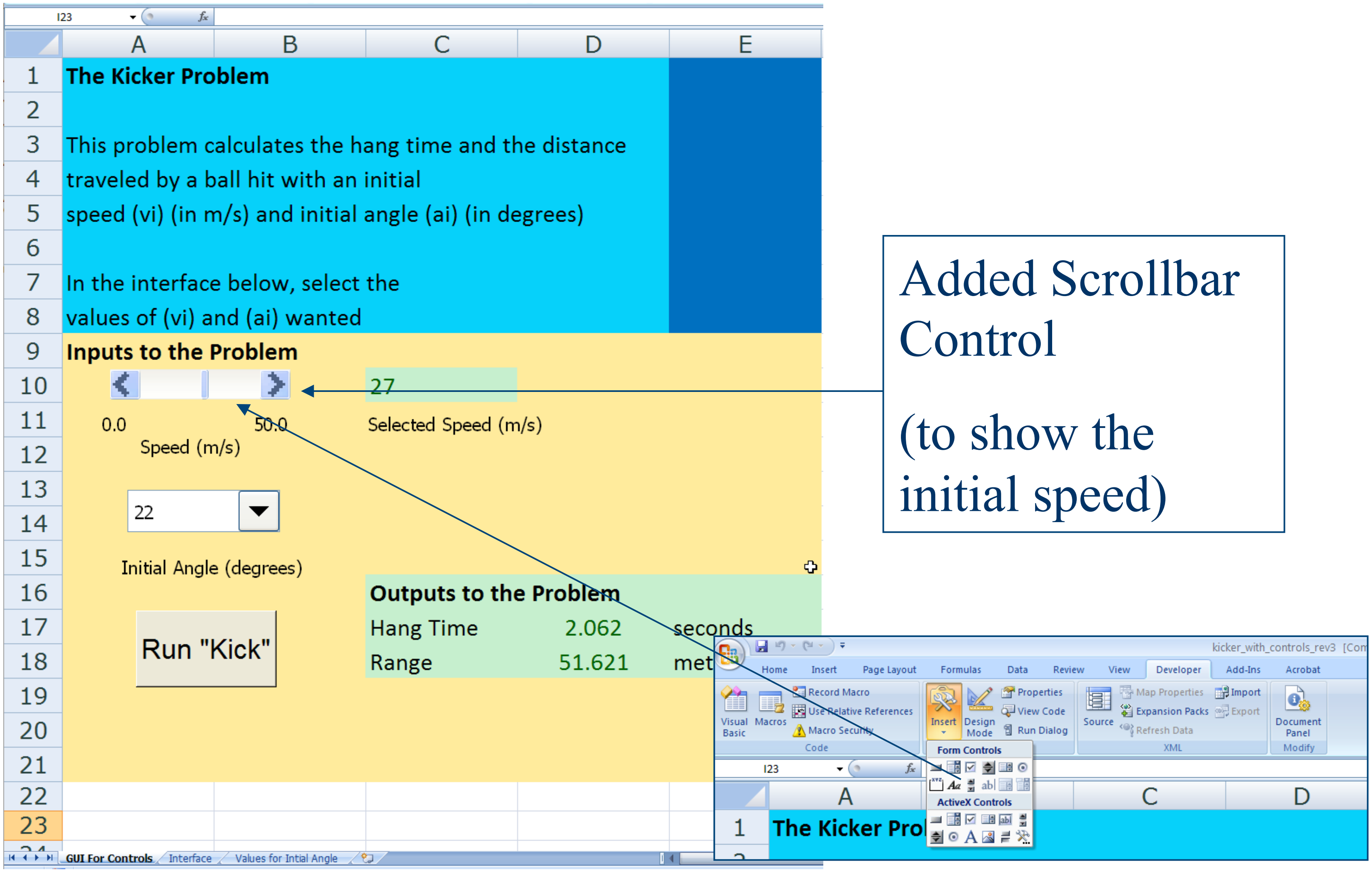
(to show controls)

Original Worksheet

Added Worksheet

(to store values of initial angle)

Scrollbar Control for GUI



The Kicker Problem

This problem calculates the hang time and the distance traveled by a ball hit with an initial speed (vi) (in m/s) and initial angle (ai) (in degrees)

In the interface below, select the values of (vi) and (ai) wanted

Inputs to the Problem

27

0.0 50.0

Speed (m/s)

Selected Speed (m/s)

22

Initial Angle (degrees)

Run "Kick"

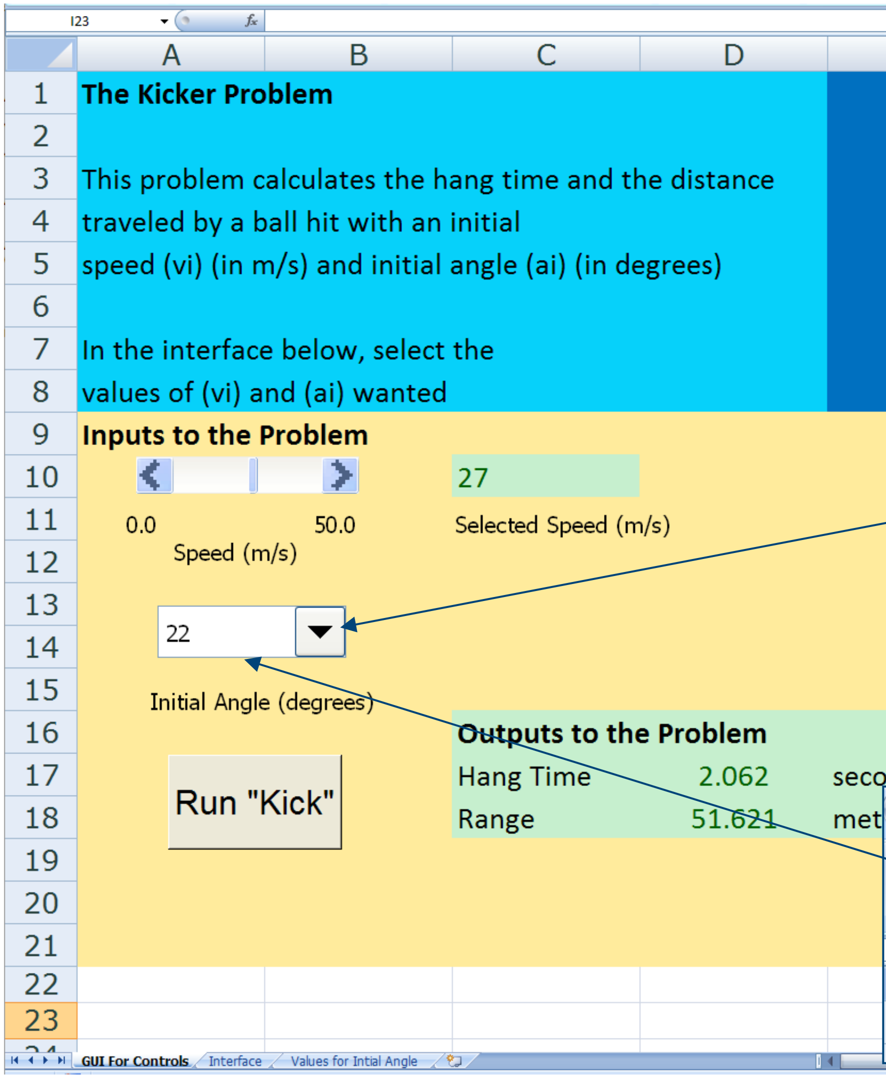
Outputs to the Problem

Hang Time	2.062	seconds
Range	51.621	met

Added Scrollbar Control

(to show the initial speed)

Combo Box Control for GUI



The Kicker Problem

This problem calculates the hang time and the distance traveled by a ball hit with an initial speed (vi) (in m/s) and initial angle (ai) (in degrees)

In the interface below, select the values of (vi) and (ai) wanted

Inputs to the Problem

0.0 50.0 Speed (m/s)	27 Selected Speed (m/s)
22 Initial Angle (degrees)	

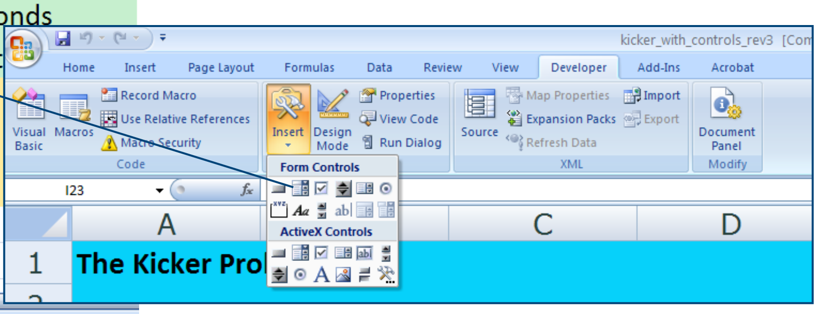
Run "Kick"

Outputs to the Problem

Hang Time	2.062	seconds
Range	51.621	met

Added Combo Box Control

(to show the initial angle)



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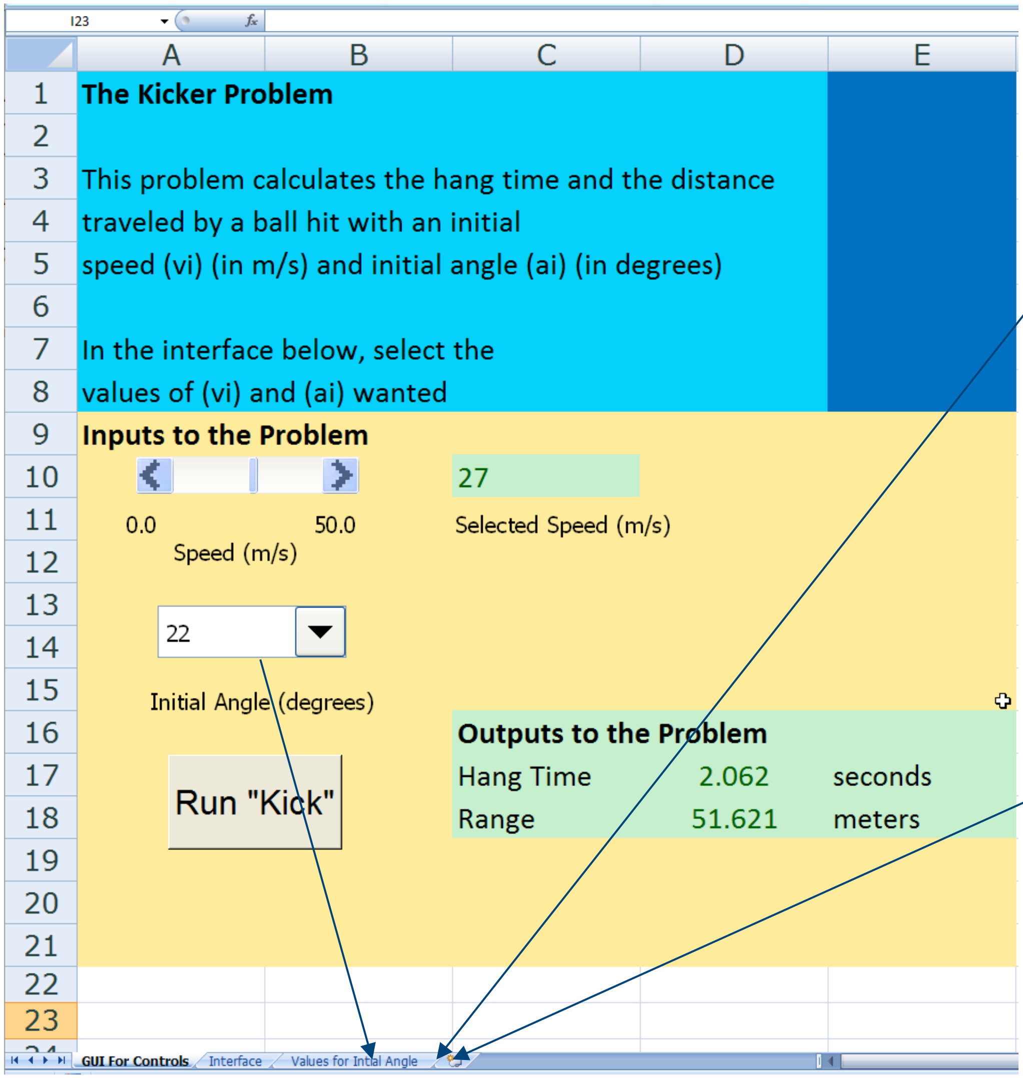
Combo Box Connection for GUI



The Kicker Problem

This problem calculates the hang time and the distance traveled by a ball hit with an initial speed (vi) (in m/s) and initial angle (ai) (in degrees)

In the interface below, select the values of (vi) and (ai) wanted

Inputs to the Problem

0.0 50.0
Speed (m/s)

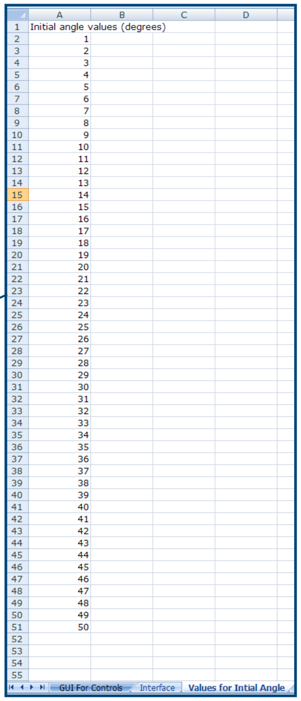
Selected Speed (m/s): 27

Initial Angle (degrees): 22

Outputs to the Problem

Hang Time	2.062	seconds
Range	51.621	meters

Connect Combo Box with worksheet (Values for Initial Angle)



	A
1	Initial angle values (degrees)
2	1
3	2
4	3
5	4
6	5
7	6
8	7
9	8
10	9
11	10
12	11
13	12
14	13
15	14
16	15
17	16
18	17
19	18
20	19
21	20
22	21
23	22
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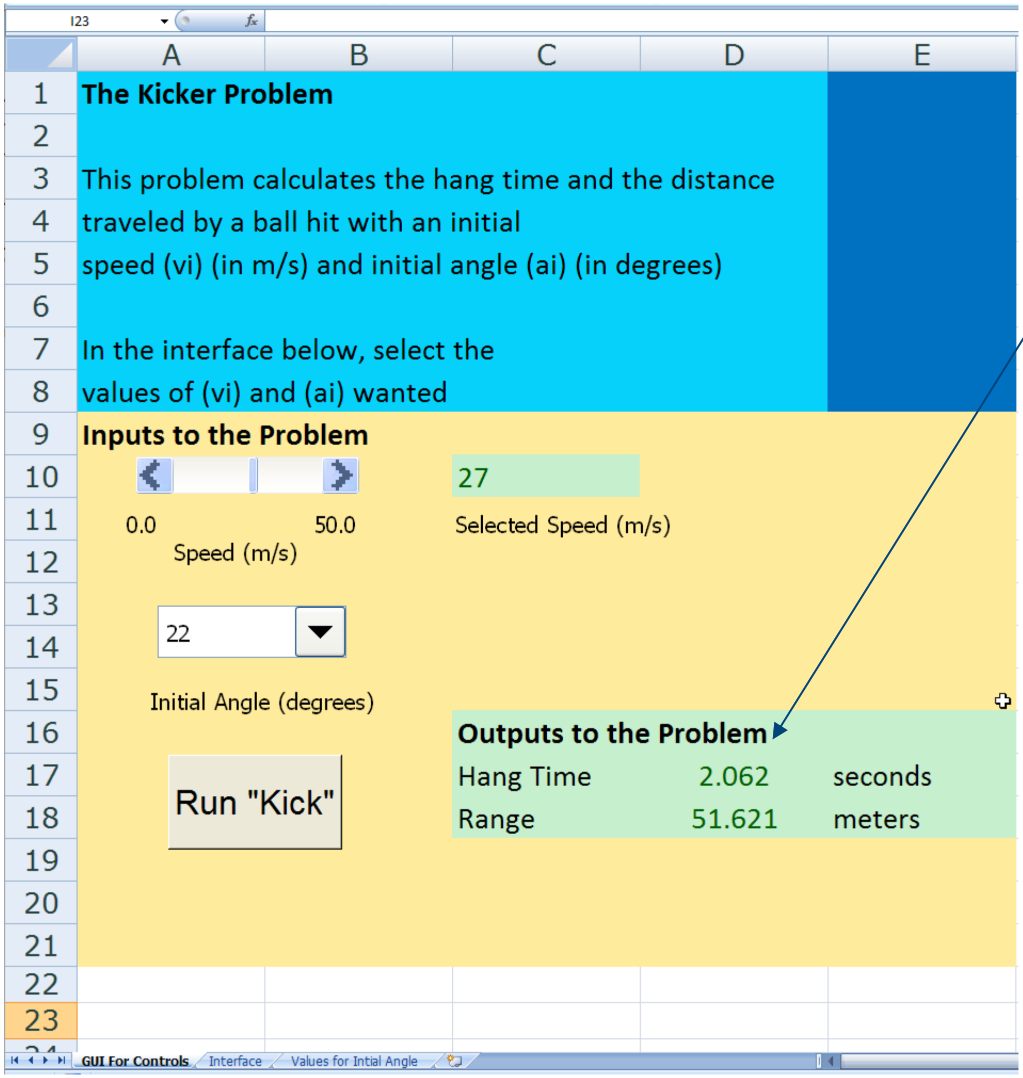
35	34
36	35
37	36
38	37
39	38
40	39
41	40
42	41
43	42
44	43
45	44
46	45
47	46
48	47
49	48
50	49
51	50
52	
53	
54	
55	

Display Outcomes in the GUI



The Kicker Problem

This problem calculates the hang time and the distance traveled by a ball hit with an initial speed (vi) (in m/s) and initial angle (ai) (in degrees)

In the interface below, select the values of (vi) and (ai) wanted

Inputs to the Problem

0.0 50.0
Speed (m/s)

27
Selected Speed (m/s)

22
Initial Angle (degrees)

Outputs to the Problem

Hang Time	2.062	seconds
Range	51.621	meters

Model Output

GUI Resources

- AskTog — Essays on good design and a list of First Principles for good user interface design. The author, Tognazzini, is a well-respected user interface designer. http://www.asktog.com/basics/firstPrinciples.html
- Galitz, Wilbert, O., Essential Guide to User Interface Design. Wiley, New York, NY, 2002.
- GUI Design Handbook — A detailed guide to the use of GUI controls. http://www.fast-consulting.com/GUI %20Design%20Handbook/ GDH_FRNTMTR.htm.

GUI Resources (More)

- Usability Glossary — An extensive glossary of terms related to GUI design, usability, and related topics. http://www.usabilityfirst.com/glossary/main.cgi.
- UsabilityNet — Covers design principles, user-centered design, and other usability and design-related topics. http://www.usabilitynet.org/management/b_design.htm