# Investment Planning Group (IPG) Progress Report #2

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#### Outline

- Problem Definition
- Technical Approach
- Task Breakdown and Status
- Progress Management
- Issues and Concerns
- Future Plans



#### **Problem Definition**

#### Problem Definition

- Options investment strategies that are rigorously modeled are usually proprietary and are the efforts of many resources
  - Determine an optimal options investment strategy
  - Balance aggressive investment against catastrophic loss
- Sponsor's Primary Objectives
  - Extend the efforts of Fall 2009 and Spring 2010 project teams to develop a more realistic simulated trading process
  - Develop an analytical model to predict the risk reward ratio of an investment strategy and validate the strategy with our simulated trading process using real data
  - Submit technical paper for publication



# **Options Trading Clarification**

- We are not trading stocks or other commodities
- Effectively selling insurance on price changes of one commodity, the E-mini S&P
  - i.e. gambling
- Always buy back the option on expiration
- Useful tool for other traders to hedge against losses in other commodities



#### **Methodology and Technical Approach**

- Extend existing Java simulated trading process GUI
  - Implement a more user-friendly front-end interface
- Improve existing simulated trading process:
  - Enumerate to find optimal Short Strangle Strategy
  - Use and improve realistic assumptions to prune search space
    - Model slippage as a function of size of trades
    - Use premium range as a parameter instead of strike price and put/call range
    - Reduce trade size when too large for market to handle
  - Use Kelly Criterion to determine optimal fractional allocation of investment
    - Marginal requirement on investment
- Implement performance prediction model(s) and recommend the optimal strategy with highest estimated profit
  - Estimate the distribution of asset prices at options expiration using Geometric Brownian Motion model
  - Estimate profit potential against feasible strategies using expected value of the asset price then select best strategy



#### Task Breakdown

- Modify simulated trading process to use more realistic assumptions
  - Use Bear-Call/Bull-Put spread options strategy instead of stop-loss orders
  - Investigate and implement models for slippage
  - Determine optimum fractional allocation of current fund balance for writing new options contracts
  - Use premium (5-25 points) instead of strike prices to parameterize writing strategies
- Improve front-end user-interface (UI)
  - Allow user to more easily modify and prune trading strategy parameters
- Implement, analyze and validate a performance prediction model to recommend the optimal investment strategy that maximizes expected profit



# **Options Trading Scenario**



- Original trading strategy using stop loss order
- Seller charges premium for selling option
- If index price crosses stop loss, option is immediately bought back
- Option is also bought back on expiration date
- Profit is initial premium minus the payment when options "stops out" or expire



# **Spread Options Strategies**

#### Bear Call Bull Put

- Combination of four contracts
  - Two contracts includes a short strangle strategy

– Other two include a long strangle

- Most Profitable when index price remains within range short strangle strike prices max profit is the total premium associated with these strike prices
- Long strangle caps risk to the total associated premiums
- Replaces stop-loss orders



#### **Profit Spread Illustrated**





### **Prediction Model Status**

- We will implement our prediction model in Excel
  - Simulate the asset price at options expiration using Geometric Brownian Motion model
    - This is more convenient to test in Excel/Simulink before implementation in software
  - Determine strike price using the Black-Scholes Model with specific premium and other parameters
    - Use the simulated asset price to determine profit at expiration
  - Using a Monte-Carlo simulation we can find the expected profit for a given strategy
  - We will analyze the performance of our prediction model for each month and option expiration date



#### **Geometric Brownian Motion**





#### **Software Development Status**

- Improved simulation speed
  - Resulted in approximately  $14N \times faster \ simulation$

-N is the number of PC cores and processors

- Trading simulation front-end UI complete
- New trading strategy implemented
- Purchased and currently incorporating S&P 500 Futures data into trading simulation
  - Previous team used S&P 500 Index data as a substitute



#### **Trading Simulation Front-End UI**

| JPG : Optimal E-Mini S&P Options Trading Strategies   |  |
|---|--|
| File Help<br>Trading Simulation Strategy Analysis   |  |
|   |  |
| Input Data Directory: ./data/input/ Browse  | Spring 2010 Strategy Spring 2011 Strategy Put Option Ranges:   |
| Trading Year:   | Min: -50 Max: -5   |
| Min:     2004     Max:     2009       Trading Days to Expiration:       Min:     15     Max:     60 | Call Option Ranges:<br>Min: 5 Max: 50  |
| Initial Investment Amount: \$1,000,000  | Strike Value Increment: 5  |
| Required Margin: \$5,000  | Stop-loss Values:         [5, 10, 15, 20, 25, 30, 35, 40, 42]           Max Volatilities:         [30, 40, 50, null] |
| Ruin Fraction: 0.50   |  |
| Strategy Output Directory: ./data/output/ Browse  |  |
| Output Filename Prefix: strangleReturns   | Run Trading Simulation   |
|   |  |
|   |  |
|   |  |
|   |  |
|   |  |
|   |  |

Status : Edit Selected Trading Strategy or Load Trading Results for Analysis

#### **Progress Management**

U

| D    | Task Name                           | Duration    | Start       | Finish      | Jan 23  | Jan 30 Feb | 6 Feb 13          | Feb 20   | Feb 27   | Mar6 M        | Mar 13 Mar | r 20 Mar 27 | Apr 3     | Apr 10  | Apr 17  | Apr 24   | lay 1      | May8 May  |
|------|-------------------------------------|-------------|-------------|-------------|---------|------------|-------------------|----------|----------|---------------|------------|-------------|-----------|---------|---------|----------|------------|-----------|
|      | Management                          | 70 days Mo  | on 1/31/11  | Fri 5/6/11  | 3 1 1 S |            | 1   1   5   M   W | 11 5 1 1 | 3 M W F  | 0   1   1   S | INT VV F S | IIIS M      | W F S I T | 3 M W F | 3 1 1 5 | ⊳_M W F  | 3    <br>0 | S M V F S |
| 2    | Meetings                            | 69 days T   | Tue 2/1/11  | Fri 5/6/11  |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 3 1  | Team Meetings                       | 69 days 1   | Tue 2/1/11  | Eri 5/6/11  |         |            | _                 |          |          |               |            | _           |           |         | _       |          | _          |           |
| 4 1  | Sponsor Meetings                    | 46 days     | Fri 2/4/11  | Fri 4/8/11  |         |            |                   | 1        | 1        |               |            |             | -         |         |         |          |            |           |
| 5 1  | Advisor Meetings                    | 5 days F    | Fri 4/15/11 | Thu 4/21/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 6    | Personal Activity Logs              | 70 days Mo  | on 1/31/11  | Fri 5/6/11  |         |            |                   |          |          |               |            |             |           |         | _       |          |            |           |
| 7    | Problem Definition and Scope        | 9 days Mo   | on 1/31/11  | Thu 2/10/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 8    | Problem Definition and Scope Prep   | 9 days Mo   | on 1/31/11  | Thu 2/10/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 9 🖬  | Problem Definition Due              | 1 day 1     | Thu 2/3/11  | Thu 2/3/11  |         | ♦ 2/3      |                   |          |          |               |            |             |           |         |         |          |            |           |
| 10 🖬 | Problem Definition and Scope Due    | 1 day Th    | hu 2/10/11  | Thu 2/10/11 |         | · ·        | 2/10              |          |          |               |            |             |           |         |         |          |            |           |
| 11   | Project Proposal                    | 5 days F    | Fri 2/11/11 | Thu 2/17/11 |         |            |                   | w l      |          |               |            |             |           |         |         |          |            |           |
| 12   | Project Proposal Prep               | 5 days H    | Fri 2/11/11 | Thu 2/17/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 13 🖩 | Project Proposal Due                | 1 day Th    | hu 2/17/11  | Thu 2/17/11 |         |            |                   | 2/17     |          |               |            |             |           |         |         |          |            |           |
| 14   | Progress Reports                    | 30 days F   | Fri 2/18/11 | Thu 3/31/11 |         |            |                   | <b>.</b> | _        |               |            | _           | -         |         |         |          |            |           |
| 15   | Progress Report #1                  | 15 days F   | Fri 2/18/11 | Thu 3/10/11 |         |            |                   | <b>v</b> | _        |               |            |             |           |         |         |          |            |           |
| 16   | Progress Report #1 Prep             | 15 days F   | Fri 2/18/11 | Thu 3/10/11 |         |            |                   |          | _        |               |            |             |           |         |         |          |            |           |
| 17   | Progress Report #1 Due              | 1 day Th    | hu 3/10/11  | Thu 3/10/11 |         |            |                   |          |          | 3/            | 10         |             |           |         |         |          |            |           |
| 18   | Progress Report #2                  | 15 days F   | Fri 3/11/11 | Thu 3/31/11 |         |            |                   |          |          | <b>v</b>      | _          |             | -         |         |         |          |            |           |
| 19   | Progress Report #2 Prep             | 15 days     | Fri 3/11/11 | Thu 3/31/11 |         |            |                   |          |          | 🎽             |            |             | ■h        |         |         |          |            |           |
| 20 🔢 | Progress Report #2 Due              | 1 day Th    | hu 3/31/11  | Thu 3/31/11 |         |            |                   |          |          |               |            |             | 3/31      |         |         |          |            |           |
| 21   | Final Report                        | 22 days     | Fri 4/1/11  | Mon 5/2/11  |         |            |                   |          |          |               |            |             | <b>1</b>  |         |         |          |            |           |
| 22   | Final Report Prep                   | 22 days     | Fri 4/1/11  | Mon 5/2/11  |         |            |                   |          |          |               |            |             | <b></b>   |         |         |          |            |           |
| 23   | Final Report Due                    | 1 day N     | Mon 5/2/11  | Mon 5/2/11  |         |            |                   |          |          |               |            |             |           |         |         |          | 5/2        |           |
| 24   | Project Website                     | 25 days     | Fri 4/1/11  | Thu 5/5/11  |         |            |                   |          |          |               |            |             |           |         | _       |          |            |           |
| 25   | Project Website Prep                | 25 days     | Fri 4/1/11  | Thu 5/5/11  |         |            |                   |          |          |               |            |             |           |         | _       |          |            |           |
| 26 🏢 | Project Website Due                 | 1 day 1     | Thu 5/5/11  | Thu 5/5/11  |         |            |                   |          |          |               |            |             |           |         |         |          |            | 5/5       |
| 27   | Final Presentation                  | 26 days     | Fri 4/1/11  | Fri 5/6/11  |         |            |                   |          |          |               |            |             | <u>.</u>  |         | _       |          | v          |           |
| 28   | Final Presentation Prep             | 26 days     | Fri 4/1/11  | Fri 5/6/11  |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 29 🎚 | Dry Run #1                          | 1 day Tr    | hu 4/28/11  | Thu 4/28/11 |         |            |                   |          |          |               |            |             |           |         |         | <b>4</b> | 28         |           |
| 30 🎚 | Dry Run #2                          | 1 day 1     | Thu 5/5/11  | Thu 5/5/11  |         |            |                   |          |          |               |            |             |           |         |         |          | ÷ 🔶        | 5/5       |
| 31 🎚 | Final Presentation                  | 1 day       | Fri 5/6/11  | Fri 5/6/11  |         |            |                   |          |          |               |            |             |           |         |         |          | *          | 5/6       |
| 32   | Research                            | 40 days? Mo | on 1/31/11  | Fri 3/25/11 |         | Ça         |                   |          |          |               |            | ~           |           |         |         |          |            |           |
| 33   | Background                          | 40 days? Mo | on 1/31/11  | Fri 3/25/11 |         | 4          |                   |          |          |               |            | V           |           |         |         |          |            |           |
| 34   | Financial Investing                 | 20 days Mo  | on 1/31/11  | Fri 2/25/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 35   | Options Trading                     | 20 days Mo  | on 1/31/11  | Fri 2/25/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 36   | Short Strangle Strategy             | 20 days N   | Non 2/7/11  | Fri 3/4/11  |         | •          |                   |          |          |               |            |             |           |         |         |          |            |           |
| 37   | Spread Options Strategies           | 16 days? F  | Fri 2/18/11 | Fri 3/11/11 |         |            |                   | -        |          |               |            |             |           |         |         |          |            |           |
| 30   | Performance Prediction Models       | 20 days Mo  | on 2/20/11  | FTI 3/25/11 |         |            |                   |          |          |               |            | _           |           |         |         |          |            |           |
| 35   | Review Previous Projects Errorts    | 20 days mu  | den 2/7/11  | FII 2/23/11 |         |            |                   | -        |          |               |            |             |           |         |         |          |            |           |
| 40   | Modeling and Simulation             | 20 days N   | lon 2/7/11  | Fri 4/22/44 |         |            |                   | 1        | -        |               |            |             |           |         |         |          |            |           |
| 41   | Tachnical Approach                  | 15 days M   | lon 2/7/11  | Eri 2/25/11 |         |            |                   |          |          |               |            |             |           |         | ~       |          |            |           |
| 43   | Model Development                   | 15 days M   | on 2/21/11  | Eri 3/11/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 44   | Software Development                | 45 days Mo  | on 2/21/11  | Fri 4/22/11 |         |            |                   |          | -        |               |            |             |           |         |         |          |            |           |
| 45   | Improve Simulation Runtime          | 10 days Mr  | on 2/21/11  | Fri 3/4/11  |         |            |                   |          |          |               |            |             |           |         | •       |          |            |           |
| 46   | Improve UI Front End                | 15 days Mo  | on 2/21/11  | Fri 3/11/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 47   | Make Assumption More Realistic      | 20 days Mo  | on 2/28/11  | Fri 3/25/11 |         |            |                   |          | Q        |               | _          |             |           |         |         |          |            |           |
| 48   | Parameterize Strategies by Premium  | 10 days Mo  | on 2/28/11  | Fri 3/11/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 49 🖩 | Implement Slippage Model            | 10 days N   | Mon 3/7/11  | Fri 3/18/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 50   | Implement Spread Options Strategies | 10 days Mo  | on 3/14/11  | Fri 3/25/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 51   | Implement Kelly Criterion           | 10 days Mo  | on 3/14/11  | Fri 3/25/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 52 🖩 | Implement Prediction Model(s)       | 25 days Mo  | on 3/21/11  | Fri 4/22/11 |         |            |                   |          |          |               | 6          |             |           |         |         |          |            |           |
| 53   | Analysis                            | 52 days Mo  | on 2/21/11  | Tue 5/3/11  |         |            |                   | <b>V</b> | -        | -             |            |             |           |         |         |          |            |           |
| 54   | Input Data Analysis                 | 10 days Mo  | on 2/21/11  | Fri 3/4/11  |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 55 🏢 | Model Analysis                      | 20 days Mo  | on 2/21/11  | Fri 3/18/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 56   | Results Analysis                    | 40 days Mo  | on 2/28/11  | Fri 4/22/11 |         |            |                   |          | <b>9</b> | -             |            |             |           |         |         |          |            |           |
| 57 🔢 | Post-processing                     | 40 days Mo  | on 2/28/11  | Fri 4/22/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 58 🗄 | Visual Analysis in UI               | 35 days N   | Mon 3/7/11  | Fri 4/22/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 59   | Compare to Previous Year's Results  | 15 days N   | Mon 3/7/11  | Fri 3/25/11 |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |
| 60 🗄 | Validate New Results                | 25 days Mo  | on 3/21/11  | Fri 4/22/11 |         |            |                   |          |          |               | •          |             |           |         |         |          |            |           |
| 61 🗄 | Recommendations                     | 12 days Mo  | on 4/18/11  | Tue 5/3/11  |         |            |                   |          |          |               |            |             |           |         |         |          |            |           |

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### **Future Tasking**

- Develop prior for initial Kelly fraction
- Implement Slippage Model in Trading Simulation
- Performance Prediction Model
  - Implement prediction model component in Excel and recommend best trading strategy
- Analysis
  - Compare new trading strategy results against previous projects
  - Test prediction model with historical data and compare with actual future data



#### **Issues and Concerns**

 May not complete Performance Prediction Model component in time to fold into Trading Simulation User-Interface.



#### References

- Chen, Tony, et. al (2010). Optimal Options Investment Strategy Final Report. Retrieved Tuesday, February 1, 2011. http://ite.gmu.edu/~klaskey/OR680/MSSEORProjectsSpring10/Investment/files/investmentallocation-may-2010.pdf
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