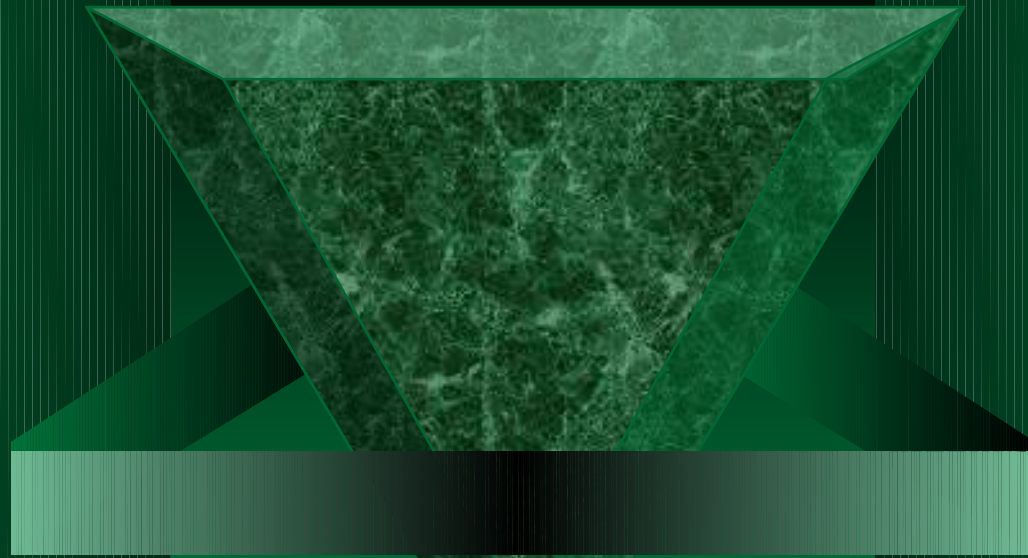
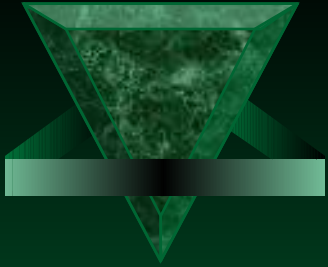


Business Plan

- ✓ Introduction
- ✓ Methodology
- ✓ Market Characterization
- ✓ Market Size and Growth
- ✓ Financial Analysis
- ✓ Next Steps



A Business Plan for the
Production of Crumb Rubber by
Solid State Shear Extrusion



Problem

- ✓ Recycling of vulcanized rubber is a challenging technical problem due to its cross-linked structure
- ✓ Conventional methods of devulcanization of scrap rubber result in degradation of polymer
 - Thermal Devulcanization
 - Chemical Devulcanization
- ✓ Solid-State Shear Extrusion (SSSE) is an ambient size reduction technique that breaks cross-link bonds



Develop Business Plan

✔ SSSE Technology

- Study SSSE process
- Evaluated pricing estimates of scaled-up version of SSSE (presently in laboratory stage)

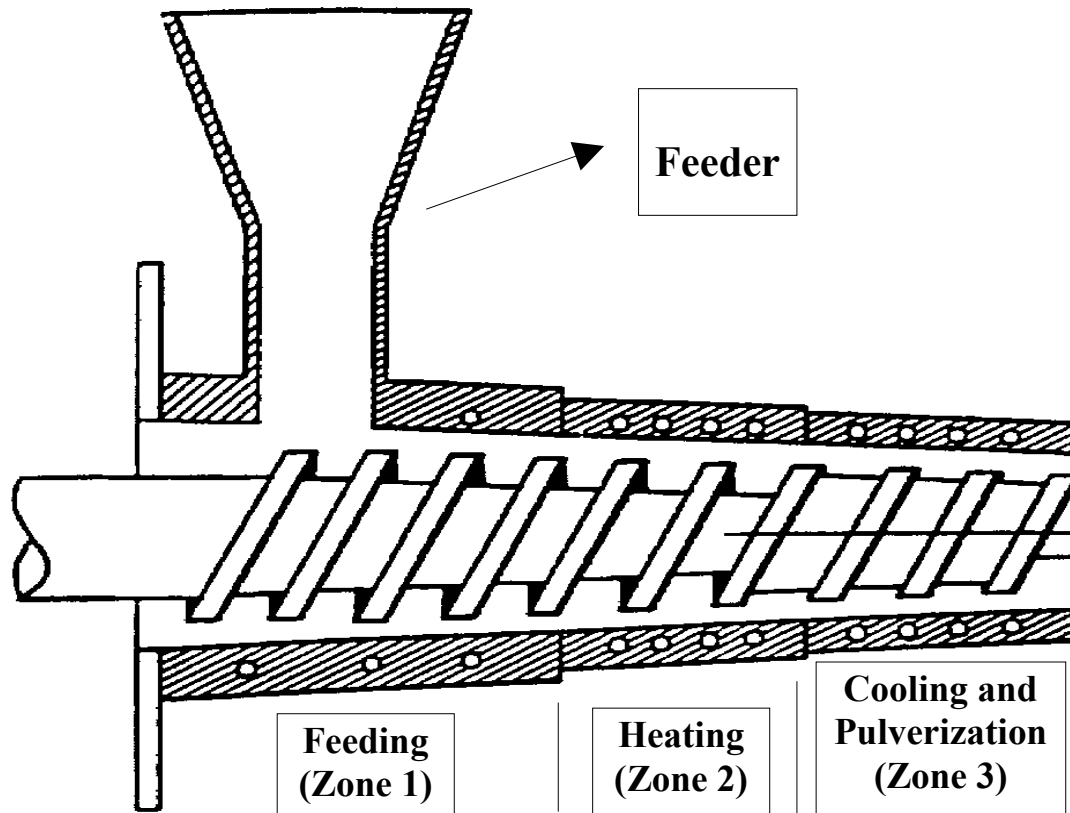
✔ Crumb Rubber Market

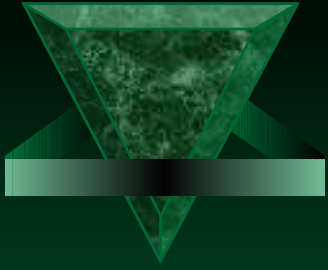
- 2002 Scrap Tire and Rubber User's Directory
- Interview crumb rubber end-users
- Interview crumb rubber producers

✔ Recommended Applications

- Rubber Modified Asphalt
- Molded Products
- Athletic Surfaces
- Miscellaneous

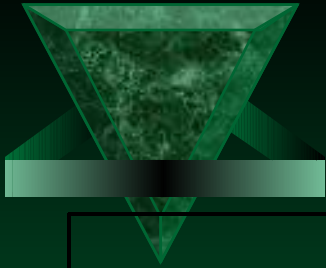
Extruder Schematic





SSSE Particle Characteristics

- ✓ Pulverized Crumb Rubber With No Chemical Additives
- ✓ No Moisture
- ✓ Approx 33% Reduction in Crosslink Density
- ✓ High Surface Area



SSSE Particle Characteristics

5:1 Screw 1SSSE

| Mesh Size | Surface area | Crosslink Reduction |
|-----------|-----------------------|---------------------------|
| 30-40 | 1600m ² /g | 21% |
| 170-60 | 2800m ² /g | 34% |
| | | |
| Mesh Size | Distribution (%) | Proposed Price (cents/lb) |
| 150 | 6.7 | 49 |
| 70 | 12.7 | 22.5 |
| 40 | 13.4 | 14.4 |
| 30 | 23.9 | 13.5 |
| 25 | 25.4 | 12.5 |
| 20 | 13.4 | 12 |
| 10 | 4.5 | 9.5 |



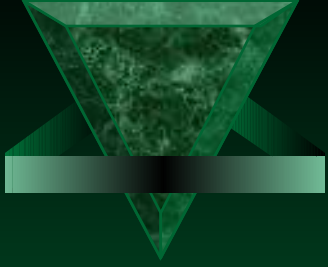
Interviews

- ✓ **54** companies in the rubber industry were interviewed.
 - **33** End-users of Crumb Rubber
 - **17** Crumb Rubber Producers
 - **7** Others: Associations, Trade Publications, etc.
- ✓ Interviews provided most accurate market assessment.



Applications of SSSE Rubber

- ✓ Flooring, Athletic Surfaces, and Molded Products
 - Anti-Fatigue Mats
 - Running Tracks
 - Playgrounds
 - Roofing
- ✓ Rubber Modified Asphalt
- ✓ Developing Applications
 - Automotive Tires
 - Adhesives
 - Paints



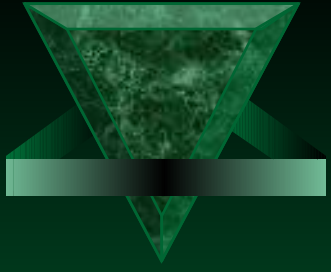
Flooring, Athletic Surfaces, and Molded Products

- ✔ These applications typically use sizes of crumb rubber that range from 20 mesh to 1"
- ✔ Within this market, the characteristics of SSSE-generated crumb rubber are comparable to that produced by other processes
- ✔ The projected SSSE price (7 - 13¢ / lb) price range is lower than the current market price (9 - 20¢ / lb)
- ✔ More market research is recommended to confidently determine the SSSE process's ability to compete on a price basis



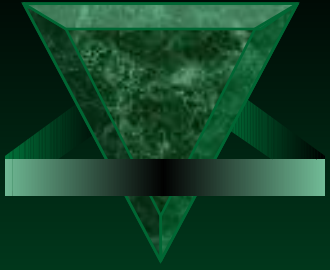
Rubber Modified Asphalt

- ✓ Uses a distribution of sizes compatible with SSSE
- ✓ Current market price (11¢ per lb) is well within estimated range for SSSE-generated crumb rubber
- ✓ Further tests on SSSE crumb rubber are recommended:
 - Reduction in cross-link density of tire rubber
 - Thermal conductivity
 - Ease of processing into RMA
 - Performance indicators of RMA made with SSSE-generated crumb rubber



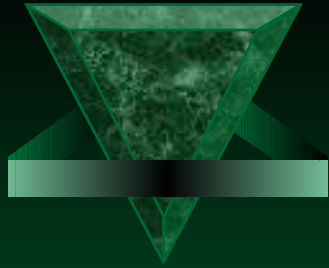
Developing Applications

- ✓ As a high-quality filler
 - Automotive tires
- ✓ Ultra-Fine Particles
 - Adhesives
 - Paint



Current Market Size

- ✓ RMA 296 Million lbs.
 - Most accessible market for SSSE
- ✓ Molded Products 307 Million lbs.
- ✓ Athletic Surfaces 141 Million lbs.
 - Running Tracks
 - Playgrounds
- ✓ Other Applications 43 Million lbs.



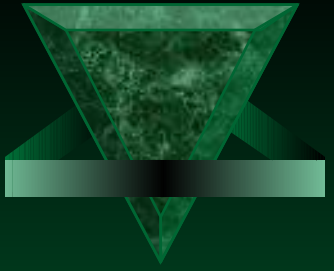
RMA Market

- ✓ Current use CA, AZ, TX, FL
- ✓ GA, NC, MD, OK, NJ, PA, NY, SC and Montreal, Canada by 2004
- ✓ 30 lbs. crumb rubber per ton asphalt
- ✓ Use limited to non structural layers of hot mix
- ✓ Approx. 10% growth per year
- ✓ Up to 570 million lbs in 2007



Molded Products

- ✓ Enormous range of products
- ✓ Average 4% growth per year
- ✓ Rubber Mats
- ✓ Molded Roof Shingles
 - Very accessible to SSSE rubber
 - About 5% of total roofing market
- ✓ Up to 375 million lbs by 2007



Athletic Surface Market

- ✓ Running Tracks and Playgrounds use close to 100% recycled rubber
- ✓ 800-1000 tracks built per year
- ✓ Several thousand playgrounds/year
- ✓ Strong lobbying for rubber surfaces in playgrounds
- ✓ Average growth 7% per year
- ✓ Up to 200 million lbs. in 2007



Summary of Market Growth

Summary of Crumb Rubber Market

| Application | 2002 Market Size (in millions of pounds) | Est. Annual % Growth | Est. 2007 Market Size (in millions of pounds) |
|---------------------------------------|---|-----------------------------|---|
| RMA | 296 | 3yrs at 10% 2 yrs at 20% | 570 |
| Molded Products | 307 | 4% | 375 |
| Sport Surfacing | 141 | 7% | 200 |
| Miscellaneous | 43 | 4% | 55 |
| Areas that are not applicable to SSSE | 209 | N/A | N/A |
| Total applicable market to SSSE | 787 | 9% | 1230 |



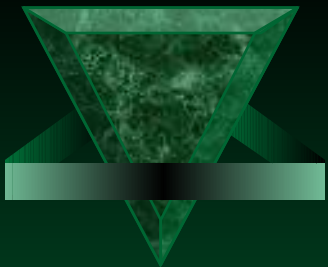
Financial Analysis

- ✓ Market Penetration in RMA, Molded Products, Athletic Surfacing, and Miscellaneous
- ✓ Profit and Loss Statement



Market Penetration

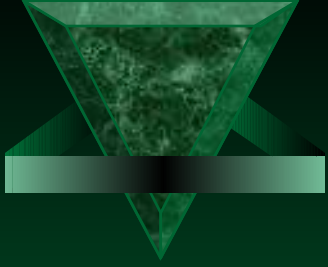
- ▼ RMA – 2% per year
- ▼ Molded Products – 1% per year
- ▼ Athletic Surfacing – 2% per year
- ▼ Miscellaneous – 1% per year



Penetration Summary

- ✓ Average price of 11.9 cents per pound
- ✓ Starting at \$1.5 Million in year one
- ✓ Growing to \$11.6 Million in year five

- ✓ Following table shows calculations



Projected Market Penetration

| All numbers in millions | 2002 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---------------------------------------|--------|--------|--------|--------|--------|--------|
| Rubber Modified Asphalt Market | | | | | | |
| Market Size (Pounds) | 296.00 | 325.60 | 358.16 | 393.98 | 472.77 | 567.33 |
| Market Share | | 2% | 4% | 6% | 8% | 10% |
| Share of Market (Pounds) | | 6.51 | 14.33 | 23.64 | 37.82 | 56.73 |
| Revenue (Average 11.9c/lb) | | \$0.77 | \$1.70 | \$2.81 | \$4.50 | \$6.75 |

| | | | | | | |
|----------------------------|--------|--------|--------|--------|--------|--------|
| Molded Products | | | | | | |
| Market Size (Pounds) | 307.00 | 319.28 | 332.05 | 345.33 | 359.15 | 373.51 |
| Market Share | | 1% | 2% | 3% | 4% | 5% |
| Share of Market (Pounds) | | 3.19 | 6.64 | 10.36 | 14.37 | 18.68 |
| Revenue (Average 11.9c/lb) | | \$0.38 | \$0.79 | \$1.23 | \$1.71 | \$2.22 |



Projected Market Penetration

| Sports Surfaces | | | | | | |
|----------------------------|--------|---------------|---------------|---------------|---------------|----------------|
| Market Size (Pounds) | 141.00 | 150.87 | 161.43 | 172.73 | 184.82 | 197.76 |
| Market Share | | 2% | 4% | 6% | 8% | 10% |
| Share of Market (Pounds) | | 3.02 | 6.46 | 10.36 | 14.79 | 19.78 |
| Revenue (Average 11.9c/lb) | | \$0.36 | \$0.77 | \$1.23 | \$1.76 | \$2.35 |
| | | | | | | |
| Misc | | | | | | |
| Market Size (Pounds) | 43.00 | 44.72 | 46.51 | 48.37 | 50.30 | 52.32 |
| Market Share | | 1% | 2% | 3% | 4% | 5% |
| Share of Market (Pounds) | | 0.45 | 0.93 | 1.45 | 2.01 | 2.62 |
| Revenue (Average 11.9c/lb) | | \$0.05 | \$0.11 | \$0.17 | \$0.24 | \$0.31 |
| | | | | | | |
| Total Pounds | | 13.17 | 28.35 | 45.81 | 68.99 | 97.80 |
| Total Dollars | | \$1.57 | \$3.37 | \$5.45 | \$8.21 | \$11.64 |



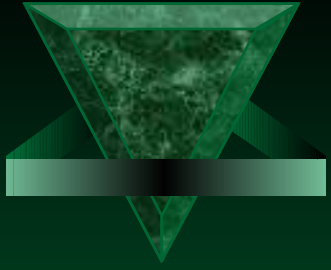
Supplemental Revenue

- ✔ Compensation for taking scrap tires
- ✔ 19 Million pounds of raw material
- ✔ Approximately 1/3 waste
- ✔ At 25 pounds per tire this would be 760,000 tires
- ✔ At 50 cents per tire this would produce \$380,000



Management Cost

- ▼ \$180,000 per year
- ▼ President – sales and admin
- ▼ Salary of \$100,000 per year
- ▼ 2 support staff
- ▼ Collectively paid \$80,000 per year
- ▼ Increases 4% annually to account for raises



Rent

▼ 10,000 square feet

▼ \$15 per square foot

▼ Total rental costs will be \$150,000



Marketing Expenses

- ✓ Commission based sales force
- ✓ 5% commission on all sales
- ✓ Expenses - \$5,000 per sales representative
- ✓ Five sales reps in year one, increase by one per year

- ✓ Promotional costs - \$100,000
 - Trade shows
 - Advertising
 - \$50,000 per year increase



Estimated Production Costs

- ✔ Electrical costs - \$50,000
- ✔ Labor - \$520,000
- ✔ Overhead - \$420,000
- ✔ Maintenance - \$150,000
- ✔ Taxes and Insurance - \$150,000



Equipment Purchase/Depreciation

- ✓ Extruder - \$280,000
 - Produces 13 million pounds per year
- ✓ Support system - \$270,000
 - Grinder
 - Shredder
 - Conveyor system
- ✓ Depreciation will be base on a twenty year amortization schedule



Estimated Net Pre-tax Income

- Based on the assumptions presented above the net pre-tax income for the SSSE process is as follows:

| Year | 1 | 2 | 3 | 4 | 5 |
|--------|-----------|-----------|-------------|-------------|-------------|
| Income | \$101,870 | \$657,027 | \$1,340,832 | \$2,250,060 | \$3,409,059 |

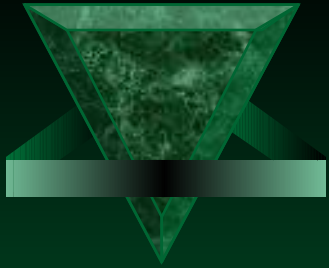
Profit and Loss Statement

| All numbers in millions | | | | | |
|------------------------------|---------------|---------------|---------------|---------------|----------------|
| Year | 1 | 2 | 3 | 4 | 5 |
| Market Share (Pounds) | 13.17 | 28.35 | 45.81 | 68.99 | 97.80 |
| Revenue | \$1.57 | \$3.37 | \$5.45 | \$8.21 | \$11.64 |
| Tire Income | \$0.38 | \$0.81 | \$1.31 | \$1.97 | \$2.79 |
| Total Revenue | \$1.94 | \$4.18 | \$6.76 | \$10.18 | \$14.43 |
| Fixed Costs | | | | | |
| Management Cost | \$0.18 | \$0.19 | \$0.19 | \$0.20 | \$0.21 |
| Rent | \$0.15 | \$0.15 | \$0.15 | \$0.15 | \$0.15 |
| Variable Costs | | | | | |
| Electrical | \$0.05 | \$0.10 | \$0.16 | \$0.25 | \$0.35 |
| Labor | \$0.52 | \$1.12 | \$1.81 | \$2.72 | \$3.86 |
| Overhead (80% labor) | \$0.42 | \$0.90 | \$1.45 | \$2.18 | \$3.09 |
| Taxes & Insurance | \$0.15 | \$0.32 | \$0.52 | \$0.78 | \$1.11 |
| Maintenance | \$0.15 | \$0.32 | \$0.52 | \$0.78 | \$1.11 |
| Sales Expenses | \$0.025 | \$0.030 | \$0.035 | \$0.040 | \$0.045 |
| Commission | \$0.08 | \$0.17 | \$0.27 | \$0.41 | \$0.58 |
| Promotional Expenses | \$0.10 | \$0.15 | \$0.20 | \$0.25 | \$0.30 |
| Depreciation | \$0.03 | \$0.09 | \$0.11 | \$0.17 | \$0.22 |
| | | | | | |
| Total Expenses | \$1.84 | \$3.53 | \$5.42 | \$7.93 | \$11.02 |
| Net Pre-tax Income | \$0.10 | \$0.65 | \$1.34 | \$2.25 | \$3.41 |
| Cumm Pre-tax Income | \$0.10 | \$0.76 | \$2.10 | \$4.35 | \$7.76 |



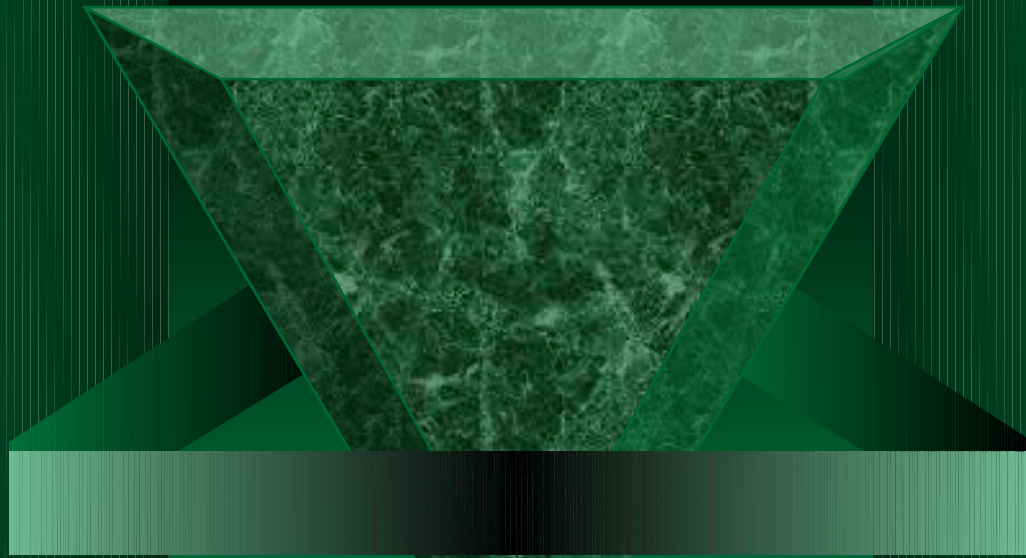
Investment Required

- ✔ Third party funding needed for three years
- ✔ Development investment - \$0.5 Million
- ✔ Investment in year one - \$1 Million
- ✔ Investment in year two - \$1 Million
- ✔ Investment in year three - \$0.5 Million
- ✔ **Total committed investment \$3 Million**



Next Steps

- Perform in-depth research into market pricing for flooring, athletic surfaces, and molded products
- Conduct materials testing on SSSE-generated crumb rubber as requested by RMA users
- Work with companies interested in developing a business using SSSE technology
 - Phoenix Recycled Products, Inc. of South Carolina
 - GreenMan Technologies of California
 - Emert Grinding of Pennsylvania



Thank You From EnPro 351

Shannon Phillips, Aidar Omarov, Michael Mroszczak,
Pete Krzyzanowski, Matt Cerney, Ginny Brock
Aaron Lebedow, Dr. Hamid Aarastoopour,
Nima Shahidi