

at least one cross-member that extends from the first loader arm to the second loader arm;

a mainframe for supporting the loader, the mainframe having a first side and a second side, and having a front end and a rear end relative to the longitudinal axis, the mainframe comprising an engine bracket that extends from the first side toward the second side for mounting an engine to the mainframe, the engine bracket being spaced from the rear end of the mainframe, the first loader arm not being directly attached to the mainframe;

a first linkage pivotally attached to the first side of the mainframe and pivotally attached to the first loader arm at a first linkage pivot point;

a second linkage pivotally attached to the first side of the mainframe and pivotally attached to the first loader arm at a second linkage pivot point, each cross-member being disposed forward of the first linkage pivot point and the second linkage pivot point;

an actuator pivotally attached to the first side of the mainframe and pivotally attached to the first loader arm at an actuator pivot point;

a control station having operator controls for propelling the compact tool carrier forward and for raising and lowering the loader, the control station being mounted toward the rear of the compact tool carrier and adapted to allow for standing or walk-behind operation; and an operator platform for standing operation of the operator controls of the control station.

51. The compact tool carrier as set forth in claim 50 wherein each cross-member is disposed forward of the actuator pivot point.

52. The compact tool carrier as set forth in claim 50 wherein the mainframe incorporates a single weldment.

53. The compact tool carrier as set forth in claim 50 further comprising an attachment plate for removably attaching a tool to the compact tool carrier, the cross-member being spaced from the attachment plate.

54. The compact tool carrier as set forth in claim 53 further comprising an actuator for tilting of tools connected to the attachment plate, the actuator being connected to the cross-member and the attachment plate.

55. A compact tool carrier configured for standing or walk-behind operator control and having a longitudinal axis and a mass of less than about 1500 kg, the compact tool carrier comprising:

a loader having an arm, the loader being adapted to carry a tool;

a mainframe for supporting the loader, the mainframe having a first side and a second side, and having a front end and a rear end relative to the longitudinal axis, the mainframe comprising an engine bracket that extends from the first side toward the second side for mounting an engine to the mainframe, the engine bracket being spaced from the rear end of the mainframe, each side having a top and a bottom, the first side of the mainframe having at least two pivot points relative to the loader, the loader arm not being directly attached to the mainframe;

a linkage pivotally attached to the first side of the mainframe and pivotally attached to the loader arm;

an actuator pivotally attached to the first side of the mainframe and pivotally attached to the loader arm;

a drive mechanism comprising tracks for propelling the compact tool carrier over a supporting surface, the drive mechanism having a rotational axis, the compact tool carrier having a bottom at which the drive mecha-

nism contacts the supporting surface, the rotational axis and bottom of the compact tool carrier being separated by a vertical distance D1, the rotational axis and the bottom of the first side of the mainframe being separated by a vertical distance D5, the rotational axis and the pivot point at which the linkage is attached to the mainframe being separated by a vertical distance D2, the rotational axis and the pivot point at which the actuator is attached to the mainframe being separated by a vertical distance D4, both D2 and D4 being less than D1 and being less than 1.5 D5; and

a control station having operator controls for propelling the compact tool carrier forward and for raising and lowering the loader, the control station being mounted toward the rear of the compact tool carrier and adapted to allow for standing or walk-behind operation.

56. The compact tool carrier as set forth in claim 55 wherein D2 and D4 are each less than 0.75 D1.

57. The compact tool carrier as set forth in claim 55 wherein the linkage is a first linkage, the compact tool carrier further comprising a second linkage pivotally attached to the first side of the mainframe at a pivot point and pivotally attached to the loader, the rotational axis and the pivot point at which the second linkage is attached to the mainframe being separated by a vertical distance D3, D3 being less than 1.5 times D1.

58. The compact tool carrier as set forth in claim 55 wherein the linkage is a first linkage, the compact tool carrier further comprising a second linkage pivotally attached to the first side of the mainframe at a pivot point and pivotally attached to the loader, wherein the mainframe comprises a forward-most pivot point with (1) the pivot point at which the first linkage is attached to the mainframe, (2) the pivot point at which the actuator is attached to the mainframe, or (3) the pivot point at which the second linkage is attached to the mainframe being the forward-most pivot point, a vertical distance between the rotational axis and the forward-most pivot point being less than D1.

59. The compact tool carrier as set forth in claim 55 wherein the linkage is a first linkage, the compact tool carrier further comprising a second linkage pivotally attached to the first side of the mainframe at a pivot point and pivotally attached to the loader, wherein the mainframe comprises a forward-most pivot point with (1) the pivot point at which the first linkage is attached to the mainframe, (2) the pivot point at which the actuator is attached to the mainframe, or (3) the pivot point at which the second linkage is attached to the mainframe being the forward-most pivot point, a vertical distance between the rotational axis and the forward-most pivot point being less than 0.75 D1.

60. The compact tool carrier as set forth in claim 55 wherein the linkage is a first linkage, the compact tool carrier further comprising a second linkage pivotally attached to the first side of the mainframe at a pivot point and pivotally attached to the loader, wherein the mainframe comprises a forward-most pivot point with (1) the pivot point at which the first linkage is attached to the mainframe, (2) the pivot point at which the actuator is attached to the mainframe, or (3) the pivot point at which the second linkage is attached to the mainframe being the forward-most pivot point, a vertical distance between the rotational axis and the forward-most pivot point being less than 0.75 D5.

61. The compact tool carrier as set forth in claim 55 wherein the drive mechanism comprises a drive sprocket, the drive sprocket rotating about the rotational axis.

62. The compact tool carrier as set forth in claim 55 further comprising an operator platform for standing operation of the operator controls of the control station.

63. The compact tool carrier as set forth in claim 55 wherein the mainframe incorporates a single weldment. 5

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(51)Int.Cl.⁸
E 0 2 F 3/34

識別記号

F I
E 0 2 F 3/34

審査請求 未請求 請求項の数5 F D （全 8 頁）

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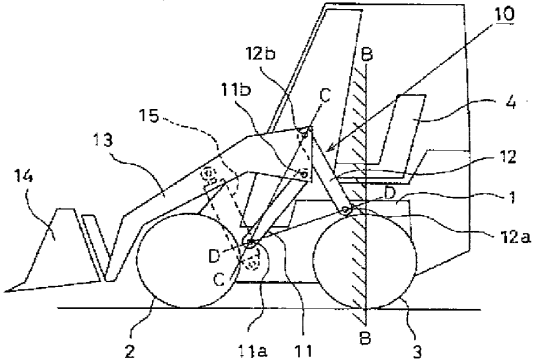
(54)【発明の名称】 作業車両の4節リンク機構

(57)【要約】

【課題】 荷積状態で乗降が可能で、視界が良く、安定性も良い作業車両の4節リンク機構を提供する。

【解決手段】 前輪（2）、後輪（3）及び運転席（4）を備える車体（1）に、前方リンク（11）及び後方リンク（12）を介して作業部材（14）を有するアーム（13）を起伏自在に取着し、4節リンク（10）を構成する。前方リンク（11）の上下端軸支部（11b、11a）と後方リンク（12）の上下端軸支部（12b、12a）とは、車体（1）を側面視するとき、後輪（3）の中心を通りかつ地面に対して垂直となる垂線（B-B）の前方側に位置している。このため、車体（1）側面からの乗降が可能で、またアーム（13）の位置が低いため視界性が良く、しかも低重心で安定性が良い。

第1実施例の4節リンクを備える作業車両の側面図



1：車体、2：前輪、3：後輪、4：運転席、10：4節リンク、
11：前方リンク、12：後方リンク、11a、12a：下端軸支部、
11b、12b：上端軸支部、13：アーム、14：バケット、
15：リフトシリンダ

【特許請求の範囲】

【請求項1】 車体(1)と、先端部に作業部材(14)を有するアーム(13)と、車体(1)の前部とアーム(13)の後部とを連結する前方リンク(11)と、車体(1)の後部と前記アーム(13)後部の近傍部位とを連結する後方リンク(12)とを備える作業車両の4節リンク機構において、作業部材(14)を地上近傍に保持した4節リンク(10)の格納姿勢時に、車体(1)に連結される前方リンク(11)の下端軸支部(11a)及び後方リンク(12)の下端軸支部(12a)と、アーム(13)に連結される前方リンク(11)の上端軸支部(11b)及び後方リンク(12)の上端軸支部(12b)とが、車体(1)を側面視するとき、後輪(3)の中心を通りかつ地面に対して垂直となる垂線の前側方に位置していることを特徴とする作業車両の4節リンク機構。

【請求項2】 請求項1記載の作業車両の4節リンク機構において、4節リンク(10)の格納姿勢時に、前方リンク(11)の上端軸支部(11b)は、前方リンク(11)の下端軸支部(11a)と後方リンク(12)の上端軸支部(12b)とを結ぶ直線よりも、後方リンク(12)側に位置していることを特徴とする作業車両の4節リンク機構。

【請求項3】 請求項1記載の作業車両の4節リンク機構において、後方リンク(12)の上端軸支部(12b)に揺動自在なベルクランク(20)を取着し、作業部材(14)とベルクランク(20)の一端とを連結してアーム(13)とでほぼ平行4節リンクを構成する前方ロッド(21)と、車体(1)とベルクランク(20)の他端とを連結して後方リンク(12)とでほぼ平行4節リンクを構成する後方ロッド(22)とを備えることを特徴とする作業車両の4節リンク機構。

【請求項4】 車体(1)と、先端部に作業部材(14)を有するアーム(13)と、車体(1)の前部とアーム(13)の後部とを連結する前方リンク(11)と、車体(1)の後部と前記アーム(13)後部の近傍部位とを連結する後方リンク(12)とを備える作業車両の4節リンク機構において、前方リンク(11)の下端軸支部(11a)及び後方リンク(12)の下端軸支部(12a)は、運転席(4)よりも下方に位置していることを特徴とする作業車両の4節リンク機構。

【請求項5】 車体(1)と、先端部に作業部材(14)を有するアーム(13)と、車体(1)の前部とアーム(13)の後部とを連結する前方リンク(11)と、車体(1)の後部と前記アーム(13)後部の近傍部位とを連結する後方リンク(12)とを備える作業車両の4節リンク機構において、車体(1)に連結される前方リンク(11)の下端軸支部(11a)及び後方リンク(12)の下端軸支部(12a)と、アーム(13)に連結される前方リンク(11)の上端軸支部(11b)及び後方リンク(12)の上端軸支部(12b)との4個所の軸支部(11a, 12a, 11b, 12b)の内、少なくとも前方リンク(11)の下端軸支部(11a)と後方リンク(12)の上端軸支部(12b)とは、作業部材(14)を地上近傍に保持した4節リンク(10)の格納姿勢時、車体(1)を側面視するとき、運転席(4)の座席指標点(24)を通りかつ地面に対して垂直とな

る垂線の前側方に位置していることを特徴とする作業車両の4節リンク機構。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、作業車両のリンク機構に係り、特に作業車両の作業機のリンク機構に関する。

【0002】

【従来の技術】図11は従来の作業車両の一例となる、装輪式の積み込み機械の第1例の側面図であり、バケット57を地上近傍に保持した4節リンクの格納姿勢を示している。車体50には前輪2、後輪3、運転室51が設けられている。車体50の後部上方には後方リンク52の下端軸支部52aが軸着され、後方リンク52の上端軸支部52bにはアーム53の後端部が軸着されている。車体50の前部には前方リンク54の下端軸支部54aが軸着され、前方リンク54の上端軸支部54bはアーム53の中央下部に設けられたアーム部53aの先端に軸着されている。以上により、4節リンク55を構成している。前方リンク54の上端軸支部54bは、前方リンク54の下端軸支部54aと後方リンク52の上端軸支部52bとを結ぶ直線K-Kより、下方に位置している。アーム53のアーム部53aの後部53bと車体50とはリフトシリンダ56により連結されている。アーム53の先端部にはバケットシリンダ(図示せず)によってチルトシダンブするバケット57が取着されている。

【0003】上記構成の作用を図12を参照して説明する。地上近傍に保持した格納姿勢のバケット57(実線で示す)は、リフトシリンダ56を伸長することにより、一点鎖線に示すように、アーム53が起立してバケット57も上昇する。このとき前方リンク54は矢印d方向に回転し、上端軸支部54bは直線K-Kに接近する。このため、後方リンク52は格納姿勢の位置から矢印eの方向に下端軸支部52aを中心として回転する。従ってバケット57は後方に移動する。さらにリフトシリンダ56を伸長すると、破線に示すように、アーム53がさらに起立してバケット57はさらに上昇する。このとき前方リンク54の上端軸支部54bは直線K-Kをよぎった後、直線K-Kから離れる。そのため、後方リンク52は破線の矢印fのように下端軸支部52aを中心として前方に回転する。従ってバケット57は前方に移動する。その間におけるバケット57の重心Gの移動軌跡は曲線Lのごとくであり、前後方向の移動量S1は小さい。

【0004】一方、車体50の側方はアーム53等が上下移動するため危険であり、図11に示すように、運転室51の側面には防護用の金網58が取着され、オペレータは車体50の前方より乗降するようになっている。

【0005】図13は装輪式の積み込み機械の第2例の

側面図である。車体60には前輪2及び後輪3が設けられ、後輪3のほぼ真上には運転席61が設けられている。車体60の前方に設けられたブラケット62の上部にはアーム63の後端軸支部63aが連結され、アーム63はリフトシリンダ64により起伏されるようになっている。アーム63の先端部にはバケット65が取着されている。オペレータは車体60の側面から乗降するようになっている。リフトシリンダ64を伸長すると、アーム63は実線の位置から一点鎖線に示すように、後端軸支部63aを中心として回転し、バケット65を上昇させる。このときのバケット65の重心Gの移動軌跡は曲線Mのごとくであり、前後方向の移動量S2はアーム後端軸支部63aの位置が固定しているため、第1例の移動量S1に比べて大きくなる。

【0006】

【発明が解決しようとする課題】しかしながら上記従来の構成には、以下のような問題がある。

(1) 第1例は、車体への乗降を車両の前方から行うため、荷積み状態では車体への乗降ができない。また横方向にアーム等があり、また後方横にもフレーム等があるため、横方向及び後横方向の視界性が悪い。

(2) 第2例は、バケット昇降時のバケット重心位置の前後方向への移動量が大きいこと、重心位置変化が大きいため、積載時の車両の前後方向の安定性が悪い。

【0007】本発明は上記の問題点に鑑み、荷積み状態でも運転席への乗降ができ、視界性が良く、しかも安定性の良い作業車両の4節リンク機構を提供することを目的とする。

【0008】

【課題を解決するための手段、作用および効果】上記の目的を達成するために、本発明に係る作業車両の4節リンク機構の第1は、車体と、先端部に作業部材を有するアームと、車体の前部とアームの後部とを連結する前方リンクと、車体の後部と前記アーム後部の近傍部位とを連結する後方リンクとを備える作業車両の4節リンク機構において、作業部材を地上近傍に保持した4節リンクの格納姿勢時に、車体に連結される前方リンクの下端軸支部及び後方リンクの下端軸支部と、アームに連結される前方リンクの上端軸支部及び後方リンクの上端軸支部とが、車体を側面視するとき、後輪の中心を通りかつ地面に対して垂直となる垂線の前方側に位置していることを特徴としている。

【0009】上記第1構成によれば、次のような作用効果を奏する。アームを車体に4節リンク機構で支持したため、4節リンクの作用により作業部材昇降時の重心の前後方向移動量を少なくして、前後方向の安定性を向上させることができる。また、前方及び後方リンクと車体及びアームとの連結点を、後輪の中心を通る垂線の前方側に位置させたため、車体側面の後方リンクの後方からオペレータの乗降が可能となる。従って積み荷状態でも

オペレータは車両への乗降が可能となる。またアームの車体への取付位置を低くでき、視界性を向上させるとともに、車体のフレーム構造を簡単にでき、重心が低くなって安定性の良い作業車両が得られる。

【0010】第2に、上記第1構成において、4節リンクの格納姿勢時に、前方リンクの上端軸支部は、前方リンクの下端軸支部と後方リンクの上端軸支部とを結ぶ直線よりも、後方リンク側に位置していることを特徴としている。

【0011】上記第2構成によれば、次のような作用効果を奏する。4節リンクの格納姿勢時に、前方リンクの下端軸支部と後方リンクの上端軸支部とを結ぶ直線に対し、前方リンクの上端軸支部を後方リンク側に位置させたため、アーム上昇時には前方リンクの上端軸支部はこの直線をよぎることとなる。このため、後方リンクは前後に回転し、作業部材の前後位置を移動させて上昇時の作業部材の重心移動量を少なくする。このため作業車両の安定性が向上する。

【0012】第3に、上記第1構成において、後方リンクの上端軸支部に揺動自在なベルクランクを取着し、作業部材とベルクランクの一端とを連結してアームとでほぼ平行4節リンクを構成する前方ロッドと、車体とベルクランクの他端とを連結して後方リンクとでほぼ平行4節リンクを構成する後方ロッドとを備えることを特徴としている。

【0013】上記第3構成によれば、次のような作用効果を奏する。前方ロッドと、後方ロッドと、アームと、作業部材と、ベルクランクと、後方リンクとでほぼ平行4節リンクを2つ構成したため、アームを起伏した場合、作業部材の対地角度がほぼ一定となる。従って荷積み状態でアームを上昇させても作業部材の対地角度がほぼ一定しているため、荷こぼれを防止するためにアームを上昇させながら作業部材の角度を調整する必要はなく、作業性が向上する。

【0014】本発明に係る作業車両の4節リンク機構の第4は、車体と、先端部に作業部材を有するアームと、車体の前部とアームの後部とを連結する前方リンクと、車体の後部と前記アーム後部の近傍部位とを連結する後方リンクとを備える作業車両の4節リンク機構において、前方リンクの下端軸支部及び後方リンクの下端軸支部が、運転席よりも下方に位置していることを特徴としている。

【0015】上記第4構成によれば、次のような作用効果を奏する。前方リンク及び後方リンクの各下端軸支部を運転席よりも下方に位置させたため、良好な視界性が得られ、かつ車体側方よりの乗降が可能となる。

【0016】本発明に係る作業車両の4節リンク機構の第5は、車体と、先端部に作業部材を有するアームと、車体の前部とアームの後部とを連結する前方リンクと、車体の後部と前記アーム後部の近傍部位とを連結する後

方リンクとを備える作業車両の4節リンク機構において、車体に連結される前方リンクの下端軸支部及び後方リンクの下端軸支部と、アームに連結される前方リンクの上端軸支部及び後方リンクの上端軸支部との4個所の軸支部の内、少なくとも前方リンクの下端軸支部と後方リンクの上端軸支部とは、作業部材を地上近傍に保持した4節リンクの格納姿勢時、車体を側面視するときに、運転席の座席指標点を通りかつ地面に対して垂直となる垂線の前方側に位置していることを特徴としている。

【0017】上記第5構成によれば、次のような作用効果を奏する。アームを車体に4節リンク機構で支持したため、上記第1構成と同様にして、前後方向の安定性を向上させることができる。また、4節リンクの格納姿勢時、少なくとも前方リンクの下端軸支部と後方リンクの上端軸支部とを、運転席の座席指標点よりも前方側に位置させたため、オペレータは、車体後部から乗降可能である。しかも、作業時における後方視界性、及び4節リンクの格納姿勢時における全方位視界性も向上できる。

【0018】

【発明の実施の形態】本発明に係る作業車両の4節リンク機構の実施例を図面を参照して詳述する。

【0019】図1は第1実施例の作業車両を示す側面図であり、作業部材14を地上近傍に保持した4節リンク10の格納姿勢を示している。本実施例では、作業部材14として、バケット14を用いている。車体1には前輪2及び後輪3が設けられ、後輪3のほぼ真上に運転席4が設けられている。尚、運転席4は、必要に応じて後輪3の前方側に又は後方側に設けてよい。車体1の側面の前輪2の後方には前方リンク11の下端軸支部11aが軸着されており、車体1の側面の後輪3の上方には後方リンク12の下端軸支部12aが軸着されている。前方リンク11の上端軸支部11bはアーム13の後部下端部に軸着され、後方リンク12の上端軸支部12bはアーム13の後部上端部に軸着されている。以上により4節リンク10を構成している。アーム13の先端部にはバケット14が取着されており、車体1の前部とアーム13とはリフトシリンダ15によって連結されている。前方リンク11の下端軸支部11a及び上端軸支部11b、並びに後方リンク12の下端軸支部12a及び上端軸支部12bは、いずれも後輪3の中心を通る垂線B-Bの前方側（ハッチング部側）に位置している。また前方リンク11の上端軸支部11bは、前方リンク11の下端軸支部11aと後方リンク12の上端軸支部12bとを結ぶ直線C-Cより、後方リンク12側に位置している。このため、アーム13と前方リンク11及び後方リンク12との連結点である上端軸支部11b、12bの位置を、低くすることができ、車両全体の重心が低くなって安定性のよい作業車両が得られる。

【0020】図2～図4はリフトシリンダ15の配置を示す斜視図である。図2はその第1取付例を示し、車体

1の前面中央下部にリフトシリンダ15の下端部を取着し、リフトシリンダ15のピストンロッド16をアーム13に連結している。

【0021】図3は第2取付例を示し、車体1の前面の左右両端部に一對のリフトシリンダ15a、15aを配置したもので、ピストンロッド16a、16aをアーム13に連結している。

【0022】図4は第3取付例を示し、車体1の前面中央上部にリフトシリンダ15bの下端部を取着し、リフトシリンダ15bのピストンロッド16bをアーム13に連結している。

【0023】次に作用を説明する。図5に示すように、地上近傍に保持した格納姿勢のアーム13及びバケット14（実線で示す）は、リフトシリンダ15を伸長することにより、一点鎖線の位置に起立し上昇する。このとき、前方リンク11が下端軸支部11aを中心にして矢印aの方向に回転し、上端軸支部11bは、その下端軸支部11aと後方リンク12の上端軸支部12bとを結ぶ直線C-C上に接近する。このため、後方リンク12は下端軸支部12aを中心として矢印bの方向に回転し、アーム13及びバケット14を格納姿勢の位置から後方に移動させる。次にさらにリフトシリンダ15を伸長すると、アーム13及びバケット14は破線で示すようにさらに起立し、上昇する。このとき、前方リンク11はさらに矢印aの方向に回転し、上端軸支部11bは直線C-Cをよぎった後に直線C-Cから離れる。同時に、後方リンク12は破線の矢印cの方向に回転し、アーム13及びバケット14を前方に移動させる。このため、バケット14の重心Gの上昇時の移動軌跡は曲線Eのごとくなり、前後方向の移動量Sが従来の積み込み機の第2例の移動量S2に比べて小さくなる。従って車両の前後方向の安定性が向上する。また運転席4は後輪3のほぼ真上に位置しているため、オペレータは車体1側方より乗降することができ、従って積み荷状態においても乗降が可能となり、作業性が向上する。

【0024】図6は作業車両の第2実施例を示す側面図である。構成は第1実施例とほぼ同一であるので、同一部材には同一記号を付し、説明は省略し、異なる部分について説明する。前方リンク11の下端軸支部11aは車体1前部の前輪2の上面2aの上方に位置しており、後方リンク12の下端軸支部12aは車体後部の後輪3の上面3aの上方に位置している。このため、前輪2及び後輪3に履帯5を巻装することができ、軟弱地等での作業を可能とし、作業性を向上することができる。また、かかる構成によれば、前方リンク11の下端軸支部11a及び後方リンク12の下端軸支部12aが運転席4の下方に位置するので、従来の図11と比較し、良好な視界性が得られ、かつ車体1側方よりの乗降が可能である。なお、運転席4の下方とは、運転席4の座面より下方でよいのであるが、構造上、運転席4の下面より下

方の方がより好ましい。

【0025】図7は作業車両の第3実施例を示す側面図であり、図6に示した作業車両の第2実施例に対し、リフトシリンダ15の装着位置を異なる位置にしたものである。即ち、第2実施例でのリフトシリンダ15の装着位置は第1実施例と同様、車体1の前方に位置させてあるが、第3実施例ではリフトシリンダ15cを車体1の左右側方の前方リンク11の下方に配設したものであり、コンパクトな構成となっている。

【0026】図8は作業車両の第4実施例を示す側面図であり、第1実施例に示した作業車両にベルクランク20を追加装着したものである。従って第1実施例と同一部材には同一符号を付して説明は省略し、異なる部分について説明する。後方リンク12の上端軸支部12bに回転自在にベルクランク20を装着する。ベルクランク20の一端とバケット14とを前方ロッド21で連結し、アーム13と、バケット14と、ベルクランク20と、前方ロッド21とで、ほぼ平行4節リンクを構成する。またベルクランク20の他端と車体1とを後方ロッド22で連結し、車体1と、後方リンク12と、ベルクランク20と、後方ロッド22とで、ほぼ平行4節リンクを構成する。このため、アーム13を上昇させたとき、バケット14の対地姿勢がほぼ同じであり、このため、積み荷状態でアーム13を上昇させるときに、荷をこぼさないためのバケット14姿勢制御を行う必要がない。つまり作業性が向上する。その他の作用、効果については第1実施例と同一なので説明は省略する。

【0027】図9は作業車両の第5実施例を示す側面図であり、前輪2の上方で、かつ車体1の前部に、前方リンク11の下端軸支部11aを軸着している。他の構成は例えば上記第1実施例と同一とした。このように構成すると、前方リンク11が長くなり、かつ前後間で伏せるような形状になる。そして、前方リンク11が長くなった分だけ、かつ前方リンク11が前後間で伏せた分だけ、移動軌跡は、例えば図5に示したバケット14の重心Gの移動軌跡Eと比べて、さらに直線に近くなる。すなわち、バケット14の前後方向の移動量は、図5の移動量Sと比べて、さらに小さくなる。従って車両の前後方向の安定性がさらに向上する。

【0028】図10は作業車両の第6実施例を示す側面図であり、前方リンク11の下端軸支部11aは、前輪2の上方で、かつ車体1の前部に軸着している。後方リンク12の下端軸支部12aは、運転席4の背もたれの基端部に相当する座席指標点(Seat Index Point: 略してSIPという)24を通る垂線D-Dに対し、後方側の位置で、車体1に軸着している。前方リンク11の上端軸支部11b及び後方リンク12の上端軸支部12bは、それぞれアーム13の後部下端部及びアーム13の後部上端部に軸着され、また共に座席指標点24に対し前方側に位置している。一対のリフトシリンダ15

a、15aは、下端部を車体1の前部の左右両側に取着し、ヒストンロッド16a、16aを左右のアーム13、13に連結している。車体1の後部側には、オペレータの乗降用ステップ25を配設している。更に、作業部材14としてフォーク14を装着している。

【0029】上記構成によっても、第5実施例と同様に、図5の移動軌跡Eと比べて、直線に近いフォーク14の移動軌跡が得られ、車両の前後方向の安定性が向上する。尚、図10では、後方リンク12の下端軸支部12aのみが垂線D-Dの後方側位置である例を示しているが、後方リンク12の下端軸支部12a及び前方リンク11の上端軸支部11bが、垂線D-Dの後方側位置となるように構成しても良い。換言すれば、4個所の軸支部11a、11b、12a、12bの内、少なくとも前方リンク11の下端軸支部11a及び後方リンク12の上端軸支部12bが、垂線D-Dの前方側位置となるように構成すれば良い。また、オペレータは、ステップ25により車体1後部から容易に乗降可能である。しかも、作業時における後方視界性、及び4節リンク10の格納姿勢時における全方位視界性も良好である。尚、作業部材14は、上記バケット14又はフォーク14に限定するものではなく、建設機械、産業機械、農業機械などで用いられる一般的な作業部材が適用可能である。

【図面の簡単な説明】

【図1】本発明に係る第1実施例の4節リンクを備える作業車両の側面図である。

【図2】本発明に係るリフトシリンダの第1取付例を示す斜視図である。

【図3】本発明に係るリフトシリンダの第2取付例を示す斜視図である。

【図4】本発明に係るリフトシリンダの第3取付例を示す斜視図である。

【図5】本発明に係る第1実施例の作動説明図である。

【図6】本発明に係る第2実施例の4節リンクを備える作業車両の側面図である。

【図7】本発明に係る第3実施例の4節リンクを備える作業車両の側面図である。

【図8】本発明に係る第4実施例の4節リンクを備える作業車両の側面図である。

【図9】本発明に係る第5実施例の4節リンクを備える作業車両の側面図である。

【図10】本発明に係る第6実施例の4節リンクを備える作業車両の側面図である。

【図11】従来の第1例の4節リンクを備える積み込み機械の側面図である。

【図12】図11の積み込み機械の作動説明図である。

【図13】従来の第2例の4節リンクを備える積み込み機械の側面図である。

【符号の説明】

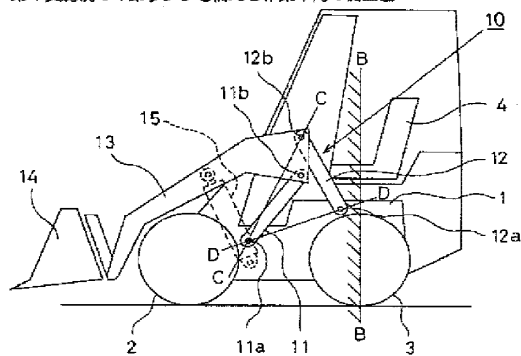
1 車体

- 2 前輪
- 3 後輪
- 4 運転席
- 5 履帯
- 10 4節リンク
- 11 前方リンク
- 12 後方リンク
- 11a、12a 下端軸支部

- 11b、12b 上端軸支部
- 13 アーム
- 14 作業部材(バケット、フォーク)
- 15、15a、15b、15c リフトシリンダ
- 20 ベルクランク
- 21 前方ロッド
- 22 後方ロッド
- 24 座席指標点

【図1】

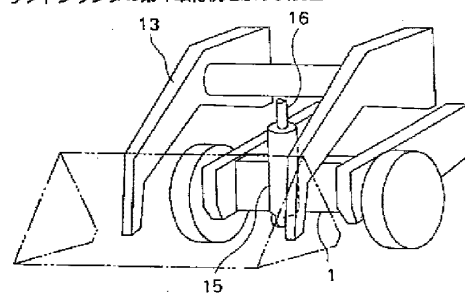
第1実施例の4節リンクを備える作業車両の側面図



- 1: 車体、2: 前輪、3: 後輪、4: 運転席、10: 4節リンク、
 11: 前方リンク、12: 後方リンク、11a、12a: 下端軸支部、
 11b、12b: 上端軸支部、13: アーム、14: バケット、
 15: リフトシリンダ

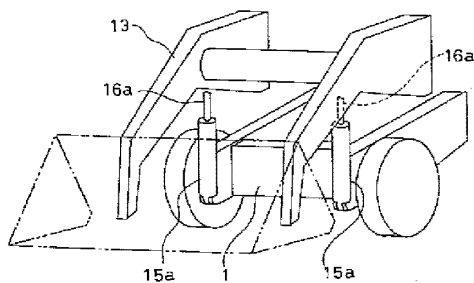
【図2】

リフトシリンダの第1取付例を示す斜視図



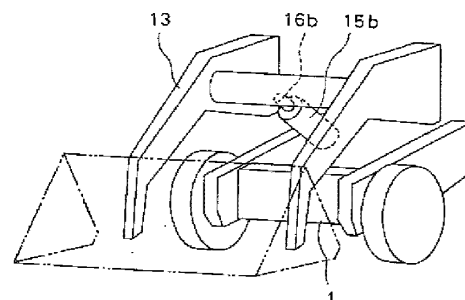
【図3】

リフトシリンダの第2取付例を示す斜視図



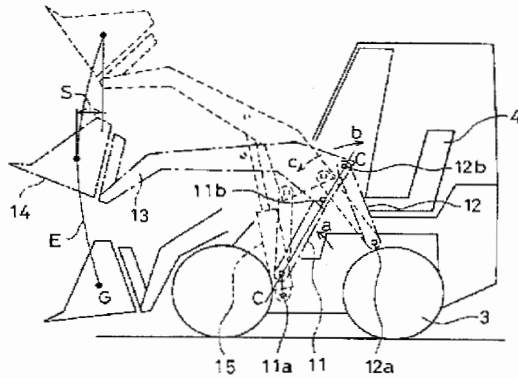
【図4】

リフトシリンダの第3取付例を示す斜視図



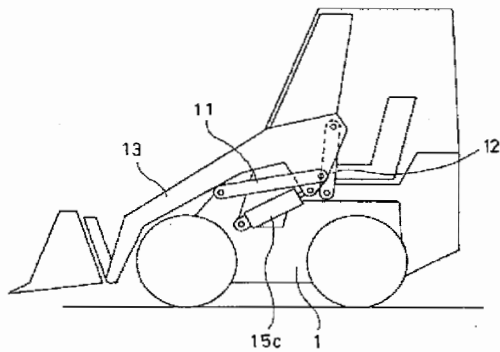
【図5】

第1実施例の作動説明図



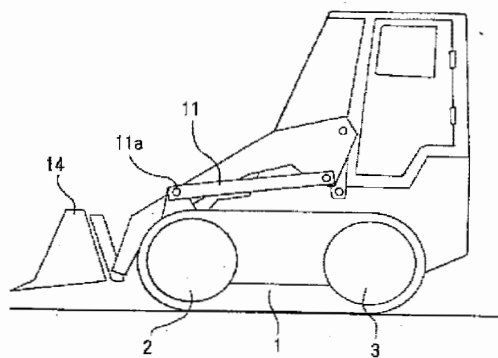
【図7】

第3実施例の4節リンクを備える作業車両の側面図



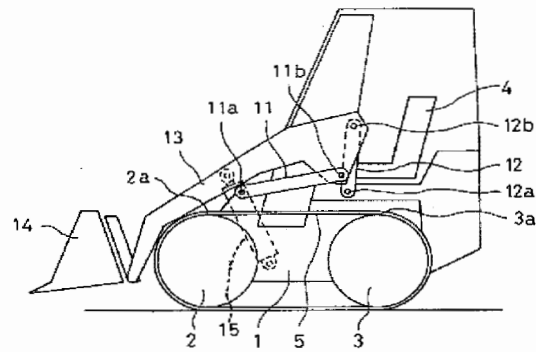
【図9】

第5実施例の4節リンクを備える作業車両の側面図



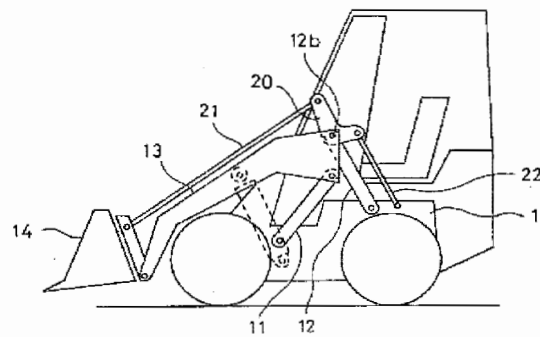
【図6】

第2実施例の4節リンクを備える作業車両の側面図



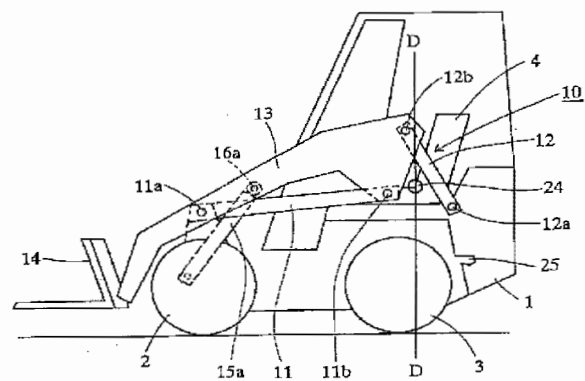
【図8】

第4実施例の4節リンクを備える作業車両の側面図



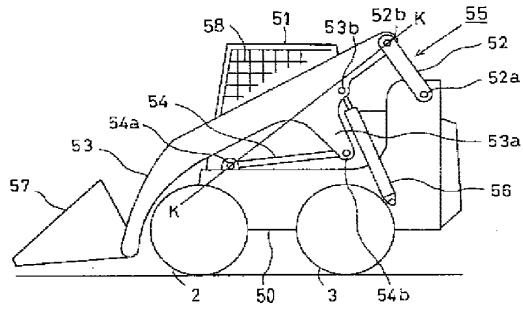
【図10】

第6実施例の4節リンクを備える作業車両の側面図



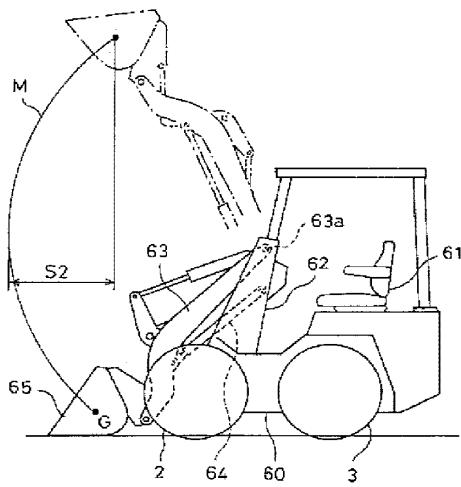
【図11】

従来の第1例の4節リンクを備えた積み込み機械の側面図



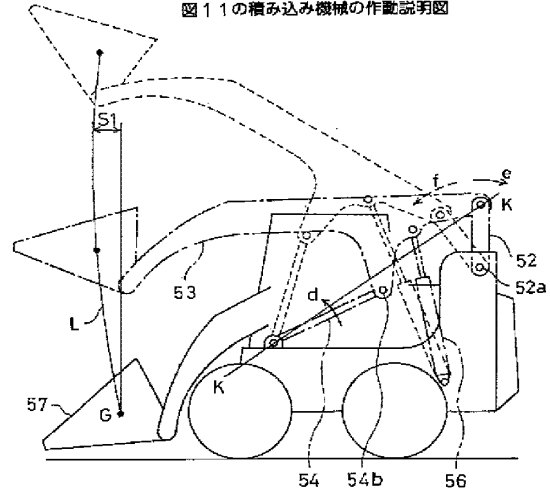
【図13】

従来の第2例の4節リンクを備えた積み込み機械の側面図



【図12】

図11の積み込み機械の作動説明図



(19) Japanese Patent Office (JP)
(12) Official Gazette for Kokai Patent Applications (A)
(11) Patent Application Kokai Number
Japanese Patent Kokai 1999-140900
(43) Kokai Publication Date May 25, 1999

(51) Int. Cl. ⁶	ID Code	FI
E02F 3/34		E02F 3/34

Examination request Not requested
Number of claims 5 FD
(Total 8 pages)

(21) Appn no.	Patent application 1998-252013
(22) Filing date	August 21, 1998
(31) Priority number	Patent application 1997-244874
(32) Priority date	August 27, 1997
(33) Priority country	Japan (JP)
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- 2 - Japanese Patent Kokai 1999-140900

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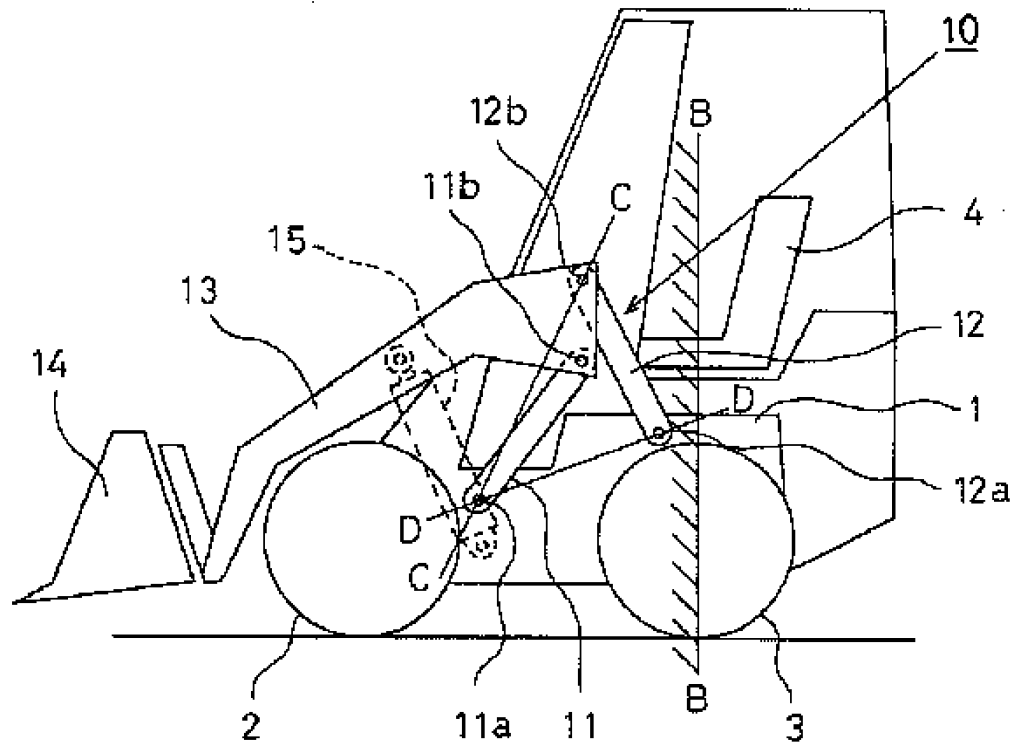
(54) [Title of the invention] Four-joint link mechanism of work vehicle

(57) [Abstract]

[Problem] To provide a four-joint link mechanism of a work vehicle which it is possible to get on and off when in a loaded state, which has a good field of vision, and which also has good stability.

[Means of overcoming the problem] An arm (13) having a work member (14) is attached by way of a forward link (11) and a rear link (12), and with freedom to be raised and lowered to a vehicle body (1) provided with a front wheel (2), a rear wheel (3) and a driver's seat (4), to configure a four-joint link (10). Upper and lower end pivot portions (11b, 11a) of the forward link (11) and upper and lower end pivot portions (12b, 12a) of the rear link (12) are positioned to the front of a vertical line (B-B) which passes through the center of the rear wheel (3) and is perpendicular to the ground surface, when the vehicle body (1) is seen from the side. It is thus possible to get on and off from the side surface of the vehicle body (1), and since the position of the arm (13) is low, visibility is good, and stability is good with a low center of gravity.

Side elevation of work vehicle provided with a four-joint link in a first exemplary embodiment



1: vehicle body, 2: front wheel, 3: rear wheel, 4: driver's seat, 10: four-joint link, 11: forward link, 12: rear link, 11a, 12a: lower end pivot portion, 11b, 12b: upper end pivot portion, 13: arm, 14: bucket, 15: lifting cylinder

[Scope of the patent claims]

[Claim 1] A four-joint link mechanism of a work vehicle provided with a vehicle body (1), an arm (13) having at a distal end thereof a work member (14), a forward link (11) coupling a front portion of the vehicle body (1) and a rear portion of the arm (13), and a rear link (12) coupling a rear portion of the vehicle body (1) and a site in the vicinity of a rear portion of the arm (13), wherein, when the four-joint link (10) is in a stowed attitude with the work member (14) held in the vicinity of the ground, a lower end pivot portion (11a) of the forward link (11) and a lower end pivot portion (12a) of the rear link (12) which are coupled to the vehicle body (1), and an upper end pivot portion (11b) of the forward link (11) and an upper end pivot portion (12b) of the rear link (12) which are coupled to the arm (13) are positioned to the front of a vertical line which passes through the center of the rear wheel (3) and is perpendicular to the ground surface, when the vehicle body (1) is seen from the side.

[Claim 2] The four-joint link mechanism of a work vehicle as claimed in claim 1, wherein, when the four-joint link (10) is in a stowed attitude, the upper end pivot portion (11b) of the forward link (11) is positioned on the rear link (12) side of a straight line joining the lower end pivot portion (11a) of the forward link (11) and the upper end pivot portion (12b) of the rear link (12).

[Claim 3] The four-joint link mechanism of a work vehicle as claimed in claim 1, wherein a swingable bell crank (20) is

attached to the upper end pivot portion (12b) of the rear link (12), and there are provided: a forward rod (21) which couples the work member (14) and one end of the bell crank (20) to form a substantially parallel four-joint link together with the arm (13); and a rear rod (22) which couples the vehicle body (1) and the other end of the bell crank (20) to form a substantially parallel four-joint link together with the rear link (12).

[Claim 4] A four-joint link mechanism of a work vehicle provided with a vehicle body (1), an arm (13) having at a distal end thereof a work member (14), a forward link (11) coupling a front portion of the vehicle body (1) and a rear portion of the arm (13), and a rear link (12) coupling a rear portion of the vehicle body (1) and a site in the vicinity of a rear portion of the arm (13), wherein a lower end pivot portion (11a) of the forward link (11) and a lower end pivot portion (12a) of the rear link (12) are positioned lower than a driver's seat (4).

[Claim 5] A four-joint link mechanism of a work vehicle provided with a vehicle body (1), an arm (13) having at a distal end thereof a work member (14), a forward link (11) coupling a front portion of the vehicle body (1) and a rear portion of the arm (13), and a rear link (12) coupling a rear portion of the vehicle body (1) and a site in the vicinity of a rear portion of the arm (13), wherein, from among four pivot portions (11a, 12a, 11b, 12b), namely a lower end pivot

portion (11a) of the forward link (11) and a lower end pivot portion (12a) of the rear link (12) which are coupled to the vehicle body (1), and an upper end pivot portion (11b) of the forward link (11) and an upper end pivot portion (12b) of the rear link (12) which are coupled to the arm (13), at least the lower end pivot portion (11a) of the forward link (11) and the upper end pivot portion (12b) of the rear link (12) are positioned to the front of a vertical line which passes through a seat index point (24) of a driver's seat (4) and is perpendicular to the ground surface, when the vehicle body (1) is seen from the side and the four-joint link (10) is in a stowed attitude with the work member (14) held in the vicinity of the ground.

[Detailed description of the invention]

[0001]

[Technical field of the invention] The present invention relates to a link mechanism of a work vehicle, and in particular relates to a link mechanism of a working machine of a work vehicle.

[0002]

[Prior art] Figure 11 is a side elevation of a first example of a wheeled loading machine, which is an example of a conventional work vehicle, illustrating an attitude in which a four-joint link is stowed with a bucket 57 held in the vicinity of the ground. A vehicle body 50 is provided with a front wheel 2, a rear wheel 3 and a driver's cab 51. A lower

end pivot portion 52a of a rear link 52 is pivotally attached at the top of a rear portion of the vehicle body 50, and a rear end portion of an arm 53 is pivotally attached to an upper end pivot portion 52b of the rear link 52. A lower end pivot portion 54a of a forward link 54 is pivotally attached to a front portion of the vehicle body 50, and an upper end pivot portion 54b of the forward link 54 is pivotally attached to a distal end of an arm portion 53a provided in a central lower portion of the arm 53. A four-joint link 55 is configured in this way. The upper end pivot portion 54b of the forward link 54 is positioned lower than a straight line K-K joining the lower end pivot portion 54a of the forward link 54 and the upper end pivot portion 52b of the rear link 52. A rear portion 53b of the arm portion 53a of the arm 53 and the vehicle body 50 are coupled to one another by means of a lifting cylinder 56. A bucket 57 which is caused to tilt for dumping by means of a bucket cylinder (which is not shown in the drawing) is attached to a distal end portion of the arm 53.

[0003] The operation of the abovementioned configuration will be described with reference to Figure 12. The bucket 57 (illustrated with a solid line) is held in the vicinity of the ground in a stowed attitude, and as illustrated by the alternate long and short dashed line, extending the lifting cylinder 56 causes the arm 53 to rise, also elevating the bucket 57. At this time the forward link 54 rotates in the

direction of the arrow d, and the upper end pivot portion 54b approaches the straight line K-K. The rear link 52 therefore rotates about the lower end pivot portion 52a in the direction of the arrow e from the stowed attitude position. The bucket 57 therefore moves rearward. If the lifting cylinder 56 is extended further, the arm 53 rises further, as illustrated by the dashed line, further elevating the bucket 57. At this time the upper end pivot portion 54b of the forward link 54 crosses the straight line K-K and then moves away from the straight line K-K. The rear link 52 therefore rotates forward about the lower end pivot portion 52a, as indicated by the dashed line arrow f. The bucket 57 therefore moves forward. The movement trajectory of the center of gravity G of the bucket 57 during this period is as indicated by the curve L, and the amount of movement S1 in the front-back direction is small.

[0004] Meanwhile, the side of the vehicle body 50 is dangerous because the arm 53 and the like move up and down, and as illustrated in Figure 11, a wire mesh 58 for protection is attached to the side surface of the driver's cab 51, and the operator gets on and off from the front of the vehicle body 50.

[0005] Figure 13 is a side elevation of a second example of a wheeled loading machine. A vehicle body 60 is provided with a front wheel 2 and a rear wheel 3, and a driver's cab 61 is provided substantially directly above the rear wheel 3. A

rear end pivot portion 63a of an arm 63 is coupled to an upper portion of a bracket 62 provided at the front of the vehicle body 60, and the arm 63 is raised and lowered by means of a lifting cylinder 64. A bucket 65 is attached to a distal end portion of the arm 63. The operator gets on and off from the side surface of the vehicle body 60. When the lifting cylinder 64 is extended, the arm 63 rotates about the rear end pivot portion 63a from the solid line position, as illustrated by the alternate long and short dashed line, elevating the bucket 65. The movement trajectory of the center of gravity G of the bucket 65 at this time is as indicated by the curve M, and an amount of movement S2 in the front-back direction is greater than the amount of movement S1 in the first example since the position of the rear end pivot portion 63a of the arm is fixed.

[0006]

[Problems to be resolved by the invention] However, the conventional configuration described hereinabove has the following problems.

(1) In the first example, since one gets on and off the vehicle body from the front of the vehicle, it is not possible to get on or off the vehicle body when in a loaded state. Further, the arm and the like are present in the lateral direction, and a frame and the like are present laterally at the rear, and therefore visibility in the lateral direction and the rearward lateral direction is poor.

(2) In the second example, since the amount of movement of the position of the center of gravity of the bucket in the front-back direction during raising and lowering of the bucket is large, there is a large variation in the position of the center of gravity, and therefore stability of the vehicle in the front-back direction when loaded is poor.

[0007] The present invention takes account of the abovementioned problems, and the objective thereof is to provide a four-joint link mechanism of a work vehicle with which it is possible to get on and off the driver's seat even in a loaded state, which has good visibility, and which also has good stability.

[0008]

[Means of overcoming the problems, operation, and effect] In order to achieve the abovementioned objective, a first aspect of a four-joint link mechanism of a work vehicle according to the present invention is provided with a vehicle body, an arm having at a distal end thereof a work member, a forward link coupling a front portion of the vehicle body and a rear portion of the arm, and a rear link coupling a rear portion of the vehicle body and a site in the vicinity of a rear portion of the arm, and is characterized in that, when the four-joint link is in a stowed attitude with the work member held in the vicinity of the ground, a lower end pivot portion of the forward link and a lower end pivot portion of the rear link which are coupled to the vehicle body, and an upper end

pivot portion of the forward link and an upper end pivot portion of the rear link which are coupled to the arm are positioned to the front of a vertical line which passes through the center of the rear wheel and is perpendicular to the ground surface, when the vehicle body is seen from the side.

[0009] According to the first configuration, the following operational advantages are exhibited. Since the arm is supported on the vehicle body by a four-joint link mechanism, the operation of the four-joint link reduces the amount of movement of the center of gravity in the front-back direction when the work member is raised and lowered, and stability in the front-back direction can thus be improved. Further, since the coupling points between the forward and rear links and the vehicle body and the arm are positioned to the front of a vertical line that passes through the center of the rear wheel, the operator can get on and off from the side surface of the vehicle body, behind the rear link. It is therefore possible for the operator to get on and off the vehicle even in a loaded state. Further, the position at which the arm is attached to the vehicle body can be made lower, improving visibility and making it possible to simplify the frame construction of the vehicle body, and the center of gravity is lowered, yielding a work vehicle having good stability.

[0010] A second aspect is characterized in that, in the first configuration, when the four-joint link is in a stowed

attitude, the upper end pivot portion of the forward link is positioned on the rear link side of a straight line joining the lower end pivot portion of the forward link and the upper end pivot portion of the rear link.

[0011] According to the second configuration, the following operational advantages are exhibited. When the four-joint link is in a stowed attitude, the upper end pivot portion of the forward link is positioned on the rear link side of a straight line joining the lower end pivot portion of the forward link and the upper end pivot portion of the rear link, and therefore the upper end pivot portion of the forward link crosses this straight line when the arm is elevated. Thus the rear link rotates forward and backward, causing the front-back position of the work member to move, and thereby reducing the amount of movement of the center of gravity of the work member when the work member is elevated. The stability of the work vehicle is thus improved.

[0012] A third aspect is characterized in that, in the first configuration, a swingable bell crank is attached to the upper end pivot portion of the rear link, and there are provided: a forward rod which couples the work member and one end of the bell crank to form a substantially parallel four-joint link together with the arm; and a rear rod which couples the vehicle body and the other end of the bell crank to form a substantially parallel four-joint link together with the rear link.

[0013] According to the third configuration, the following operational advantages are exhibited. The forward rod, the rear rod, the arm, the work member, the bell crank and the rear link form two substantially parallel four-joint links, and therefore when the arm is raised and lowered, the angle of the work member relative to the ground is substantially constant. Therefore, since the angle of the work member relative to the ground is substantially constant even when the arm is elevated in a loaded state, it is not necessary to adjust the angle of the work member in order to prevent spillage of the load while the arm is being elevated, and thus workability is improved.

[0014] A fourth aspect of a four-joint link mechanism of a work vehicle according to the present invention is provided with a vehicle body, an arm having at a distal end thereof a work member, a forward link coupling a front portion of the vehicle body and a rear portion of the arm, and a rear link coupling a rear portion of the vehicle body and a site in the vicinity of a rear portion of the arm, characterized in that a lower end pivot portion of the forward link and a lower end pivot portion of the rear link are positioned lower than a driver's seat.

[0015] According to the fourth configuration, the following operational advantages are exhibited. Since the lower end pivot portions of the forward link and the rear link are positioned lower than the driver's seat, good visibility can

be obtained, and it is possible to get on and off from the side of the vehicle body.

[0016] A fifth aspect of a four-joint link mechanism of a work vehicle according to the present invention is provided with a vehicle body, an arm having at a distal end thereof a work member, a forward link coupling a front portion of the vehicle body and a rear portion of the arm, and a rear link coupling a rear portion of the vehicle body and a site in the vicinity of a rear portion of the arm, characterized in that, from among four pivot portions, namely a lower end pivot portion of the forward link and a lower end pivot portion of the rear link which are coupled to the vehicle body, and an upper end pivot portion of the forward link and an upper end pivot portion of the rear link which are coupled to the arm, at least the lower end pivot portion of the forward link and the upper end pivot portion of the rear link are positioned to the front of a vertical line which passes through a seat index point of a driver's seat and is perpendicular to the ground surface, when the vehicle body is seen from the side and the four-joint link is in a stowed attitude with the work member held in the vicinity of the ground.

[0017] According to the fifth configuration, the following operational advantages are exhibited. Since the arm is supported on the vehicle body by a four-joint link mechanism, stability in the front-back direction can be improved in the same way as in the first configuration. Further, when the

four-joint link is in a stowed attitude, at least the lower end pivot portion of the forward link and the upper end pivot portion of the rear link are positioned to the front of a seat index point of a driver's seat, and therefore the operator can get on and off from the rear of the vehicle body. Furthermore, rearward visibility during operation and omnidirectional visibility when the four-joint link is in a stowed attitude can also be improved.

[0018]

[Modes of embodying the invention] Exemplary embodiments of the four-joint link mechanism of a work vehicle according to the present invention will be described in detail with reference to the drawings.

[0019] Figure 1 is a side elevation illustrating a work vehicle in a first exemplary embodiment, illustrating an attitude in which a four-joint link 10 is stowed with a work member 14 held in the vicinity of the ground. In this exemplary embodiment a bucket 14 is used as the work member 14. A vehicle body 1 is provided with a front wheel 2 and a rear wheel 3, and a driver's seat 4 is provided substantially directly above the rear wheel 3. It should be noted that the driver's seat 4 may be provided to the front or to the rear of the rear wheel 3 as necessary. A lower end pivot portion 11a of a forward link 11 is pivotally attached to a side surface of the vehicle body 1 behind the front wheel 2, and a lower end pivot portion 12a of a rear link 12 is pivotally

attached to the side surface of the vehicle body 1 above the rear wheel 3. An upper end pivot portion 11b of the forward link 11 is pivotally attached to a lower end portion of a rear portion of an arm 13, and an upper end pivot portion 12b of the rear link 12 is pivotally attached to an upper end portion of the rear portion of the arm 13. The four-joint link 10 is configured in this way. The bucket 14 is attached to a distal end portion of the arm 13, and a front portion of the vehicle body 1 and the arm 13 are coupled to one another by means of a lifting cylinder 15. The lower end pivot portion 11a and the upper end pivot portion 11b of the forward link 11, and the lower end pivot portion 12a and the upper end pivot portion 12b of the rear link 12 are all positioned to the front (the hatched side) of a vertical line B-B passing through the center of the rear wheel 3. Further, the upper end pivot portion 11b of the forward link 11 is positioned on the rear link 12 side of a straight line C-C joining the lower end pivot portion 11a of the forward link 11 and the upper end pivot portion 12b of the rear link 12. Thus the positions of the upper end pivot portions 11b, 12b, which are coupling points between the arm 13 and the forward link 11 and the rear link 12, can be lowered, lowering the center of gravity of the entire vehicle, and yielding a work vehicle having good stability.

[0020] Figure 2 to Figure 4 are perspective views illustrating the arrangement of the lifting cylinder 15.

Figure 2 illustrates a first attachment example in which a lower end portion of the lifting cylinder 15 is attached to a central lower portion of a front surface of the vehicle body 1, and a piston rod 16 of the lifting cylinder 15 is coupled to the arm 13.

[0021] Figure 3 illustrates a second attachment example in which a pair of lifting cylinders 15a, 15a are disposed at the left and right ends of the front surface of the vehicle body 1, and piston rods 16a, 16a are coupled to the arm 13.

[0022] Figure 4 illustrates a third attachment example in which a lower end portion of a lifting cylinder 15b is attached to a central upper portion of the front surface of the vehicle body 1, and a piston rod 16b of the lifting cylinder 15b is coupled to the arm 13.

[0023] The operation will now be described. As illustrated in Figure 5, extending the lifting cylinder 15 causes the arm 13 and the bucket 14 (illustrated with a solid line) held in the vicinity of the ground in a stowed attitude, to rise and be elevated, as illustrated by the alternate long and short dashed line. At this time, the forward link 11 rotates about the lower end pivot portion 11a in the direction of the arrow a, and the upper end pivot portion 11b approaches the straight line C-C joining the lower end pivot portion 11a and the upper end pivot portion 12b of the rear link 12. The rear link 12 therefore rotates about the lower end pivot portion 12a in the direction of the arrow b, and is moved backward

from the position thereof when the arm 13 and the bucket 14 are in the stowed attitude. Next, if the lifting cylinder 15 is extended further, the arm 13 and the bucket 14 rise and are elevated further, as illustrated by the dashed line. At this time, the forward link 11 rotates further in the direction of the arrow a, and the upper end pivot portion 11b crosses the straight line C-C and then moves away from the straight line C-C. At the same time, the rear link 12 rotates in the direction of the dashed line arrow c, moving the arm 13 and the bucket 14 forwards. Thus the movement trajectory of the center of gravity G of the bucket 14 when being elevated is as indicated by the curve E, and an amount of movement S in the front-back direction is less than the amount of movement S2 in the second example of a conventional loading machine. The stability of the vehicle in the front-back direction therefore improves. Further, since the driver's seat 4 is positioned substantially directly above the rear wheel 3, the operator can get on and off from the side of the vehicle body 1, and can therefore get on and off even when in a loaded state, improving workability.

[0024] Figure 6 is a side view illustrating a second exemplary embodiment of a work vehicle. Since the configuration is substantially the same as in the first exemplary embodiment, identical members are denoted using the same symbols, descriptions thereof are omitted, and parts that differ are described. The lower end pivot portion 11a of

the forward link 11 is positioned on a front portion of the vehicle body 1 above an upper surface 2a of the front wheel 2, and the lower end pivot portion 12a of the rear link 12 is positioned on a rear portion of the vehicle body above an upper surface 3a of the rear wheel 3. A crawler track 5 can therefore be wound around the front wheel 2 and the rear wheel 3, enabling work to be performed on soft ground or the like, and making it possible to increase workability. Further, according to said configuration, the lower end pivot portion 11a of the forward link 11 and the lower end pivot portion 12a of the rear link 12 are positioned lower than the driver's seat 4, and therefore better visibility can be obtained than in the conventional example in Figure 11, and it is also possible to get on and off from the side of the vehicle body 1. It should be noted that to be lower than the driver's seat 4, it is sufficient to be lower than a seating surface of the driver's seat 4, but in terms of the structure, it is more preferable to be lower than a lower surface of the driver's seat 4.

[0025] Figure 7 is a side view illustrating a third exemplary embodiment of a work vehicle, in which the mounting position of the lifting cylinder 15 is set to a different position to that in the second exemplary embodiment of a work vehicle illustrated in Figure 6. To elaborate, the mounting position of the lifting cylinder 15 in the second exemplary embodiment is positioned at the front of the vehicle body 1 as in the

first exemplary embodiment, but in the third exemplary embodiment lifting cylinders 15c are disposed below the forward link 11 on the left and right sides of the vehicle body 1, providing a compact structure.

[0026] Figure 8 is a side view illustrating a fourth exemplary embodiment of a work vehicle, in which a bell crank 20 is additionally mounted on the work vehicle illustrated in the first exemplary embodiment. Members that are the same as in the first exemplary embodiment are therefore denoted using the same symbols, and descriptions thereof are omitted, the description covering parts that differ. The bell crank 20 is mounted with freedom to rotate on the upper end pivot portion 12b of the rear link 12. One end of the bell crank 20 and the bucket 14 are coupled using a forward rod 21, and the arm 13, the bucket 14, the bell crank 20 and the forward rod 21 form a substantially parallel four-joint link. Further, the other end of the bell crank 20 and the vehicle body 1 are coupled using a rear rod 22, and the vehicle body 1, the rear link 12, the bell crank 20 and the rear rod 22 form a substantially parallel four-joint link. Thus the attitude of the bucket 14 relative to the ground is substantially the same when the arm 13 has been elevated, and it is therefore not necessary to perform attitude control of the bucket 14 to prevent load spillage when the arm 13 is being elevated in a loaded state. In other words, workability is improved. Other operations and effects are the same as in the first exemplary

embodiment, so descriptions thereof are omitted.

[0027] Figure 9 is a side view illustrating a fifth exemplary embodiment of a work vehicle, in which the lower end pivot portion 11a of the forward link 11 is pivotally attached to a front portion of the vehicle body 1, above the front wheel 2. Other aspects of the configuration are the same as in the first exemplary embodiment, for example. With such a configuration, the forward link 11 becomes longer, and is shaped to lie between the front and back. Further, the movement trajectory becomes closer to a straight line than the movement trajectory E of the center of gravity G of the bucket 14 illustrated in Figure 5, for example, by an amount corresponding to the lengthening of the forward link 11 and by an amount corresponding to the fact that the forward link 11 is lying down between the front and the back. In other words, the amount of movement of the bucket 14 in the front-back direction is even smaller than the amount of movement S in Figure 5. The stability of the vehicle in the front-back direction therefore improves further.

[0028] Figure 10 is a side view illustrating a sixth exemplary embodiment of a work vehicle, in which the lower end pivot portion 11a of the forward link 11 is pivotally attached to a front portion of the vehicle body 1, above the front wheel 2. The lower end pivot portion 12a of the rear link 12 is pivotally attached to the vehicle body 1 in a position to the rear of a vertical line D-D passing through a

seat index point (abbreviated to SIP) 24 corresponding to a base end portion of a backrest of the driver's seat 4. The upper end pivot portion 11b of the forward link 11 and the upper end pivot portion 12b of the rear link 12 are pivotally attached to a lower end portion of a rear portion of the arm 13 and an upper end portion of the rear portion of the arm 13 respectively, and are both positioned to the front of the seat index point 24. Lower end portions of a pair of lifting cylinders 15a, 15a are attached to the left and right sides of a front portion of the vehicle body, and piston rods 16a, 16a are coupled to left and right arms 13, 13. A step 25 for the operator to get on and off is disposed at the rear side of the vehicle body 1. Further, a fork 14 is attached as the work member 14.

[0029] According to the abovementioned configuration, in the same way as in the fifth exemplary embodiment, a movement trajectory of the fork 14 that is closer to a straight line than the movement trajectory E in Figure 5 can be obtained, improving the stability of the vehicle in the front-back direction. It should be noted that Figure 10 illustrates an example in which only the lower end pivot portion 12a of the rear link 12 is positioned to the rear of the vertical line D-D, but the configuration may be such that the lower end pivot portion 12a of the rear link 12 and the upper end pivot portion 11b of the forward link 11 are positioned to the rear of the vertical line D-D. In other words, the configuration

should be such that from among the four pivot portions 11a, 11b, 12a, 12b, at least the lower end pivot portion 11a of the forward link 11 and the upper end pivot portion 12b of the rear link 12 are positioned to the front of the vertical line D-D. Further, the operator can easily get on and off from the rear of the vehicle body 1 using the step 25. Furthermore, rearward visibility during operation and omnidirectional visibility when the four-joint link 10 is in a stowed attitude are also good. It should be noted that the work member 14 is not limited to the bucket 14 or the fork 14 described hereinabove, and typical work members used with construction machines, industrial machines, agricultural machines and the like can be applied.

[Brief description of the drawings]

[Figure 1] is a side elevation of a work vehicle provided with a four-joint link in a first exemplary embodiment of the present invention.

[Figure 2] is a perspective view illustrating a first attachment example of a lifting cylinder according to the present invention.

[Figure 3] is a perspective view illustrating a second attachment example of a lifting cylinder according to the present invention.

[Figure 4] is a perspective view illustrating a third attachment example of a lifting cylinder according to the present invention.

[Figure 5] is an explanatory view of the operation of the first exemplary embodiment of the present invention.

[Figure 6] is a side elevation of a work vehicle provided with a four-joint link in a second exemplary embodiment of the present invention.

[Figure 7] is a side elevation of a work vehicle provided with a four-joint link in a third exemplary embodiment of the present invention.

[Figure 8] is a side elevation of a work vehicle provided with a four-joint link in a fourth exemplary embodiment of the present invention.

[Figure 9] is a side elevation of a work vehicle provided with a four-joint link in a fifth exemplary embodiment of the present invention.

[Figure 10] is a side elevation of a work vehicle provided with a four-joint link in a sixth exemplary embodiment of the present invention.

[Figure 11] is a side elevation of a loading machine provided with a first example of a conventional four-joint link.

[Figure 12] is an explanatory view of the operation of the loading machine in Figure 11.

[Figure 13] is a side elevation of a loading machine provided with a second example of a conventional four-joint link.

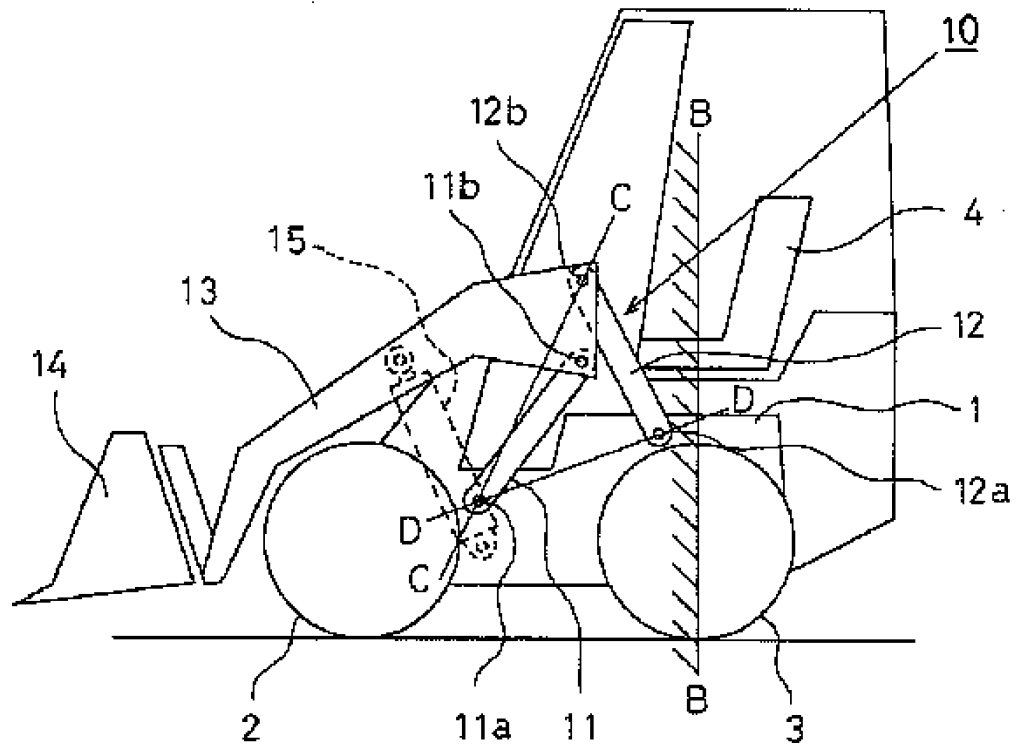
[Explanation of the reference codes]

- 1 Vehicle body
- 2 Front wheel

- 3 Rear wheel
- 4 Driver's seat
- 5 Crawler track
- 10 Four-joint link
- 11 Forward link
- 12 Rear link
- 11a, 12a Lower end pivot portion
- 11b, 12b Upper end pivot portion
- 13 Arm
- 14 Work member (bucket, fork)
- 15, 15a, 15b, 15c Lifting cylinder
- 20 Bell crank
- 21 Forward rod
- 22 Rear rod
- 24 Seat index point

[Figure 1]

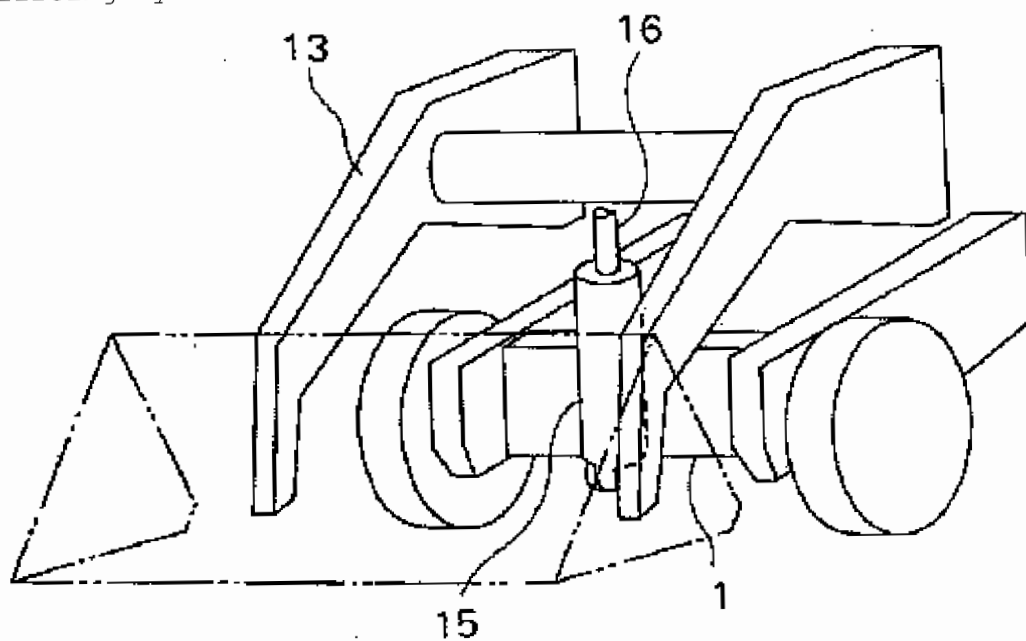
Side elevation of work vehicle provided with a four-joint link in a first exemplary embodiment



1: vehicle body, 2: front wheel, 3: rear wheel, 4: driver's seat, 10: four-joint link, 11: forward link, 12: rear link, 11a, 12a: lower end pivot portion, 11b, 12b: upper end pivot portion, 13: arm, 14: bucket, 15: lifting cylinder

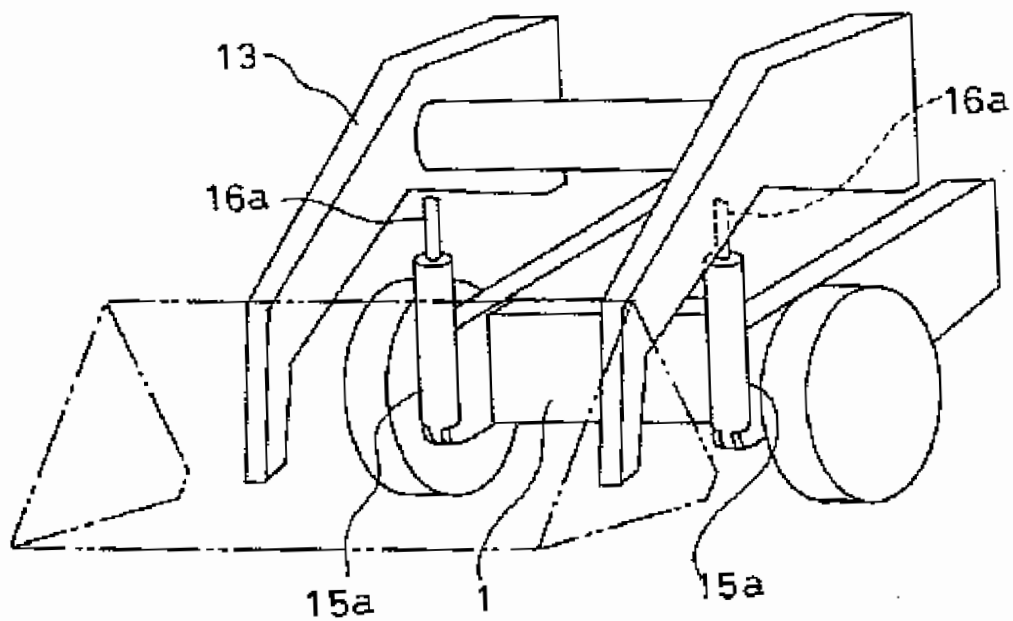
[Figure 2]

Perspective view illustrating first attachment example of lifting cylinder

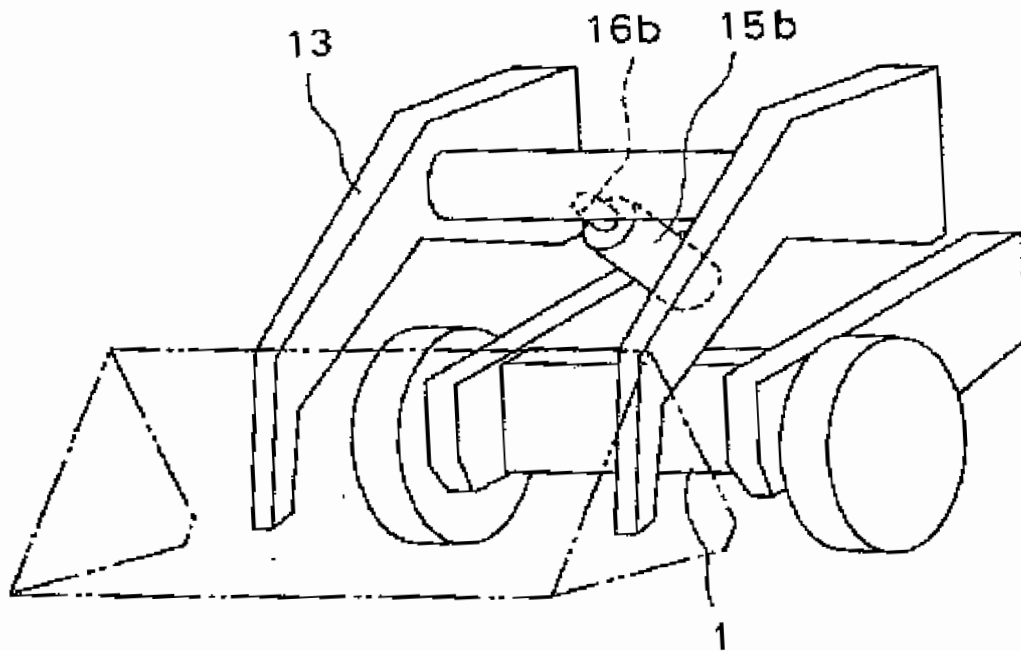


[Figure 3]

Perspective view illustrating second attachment example of lifting cylinder

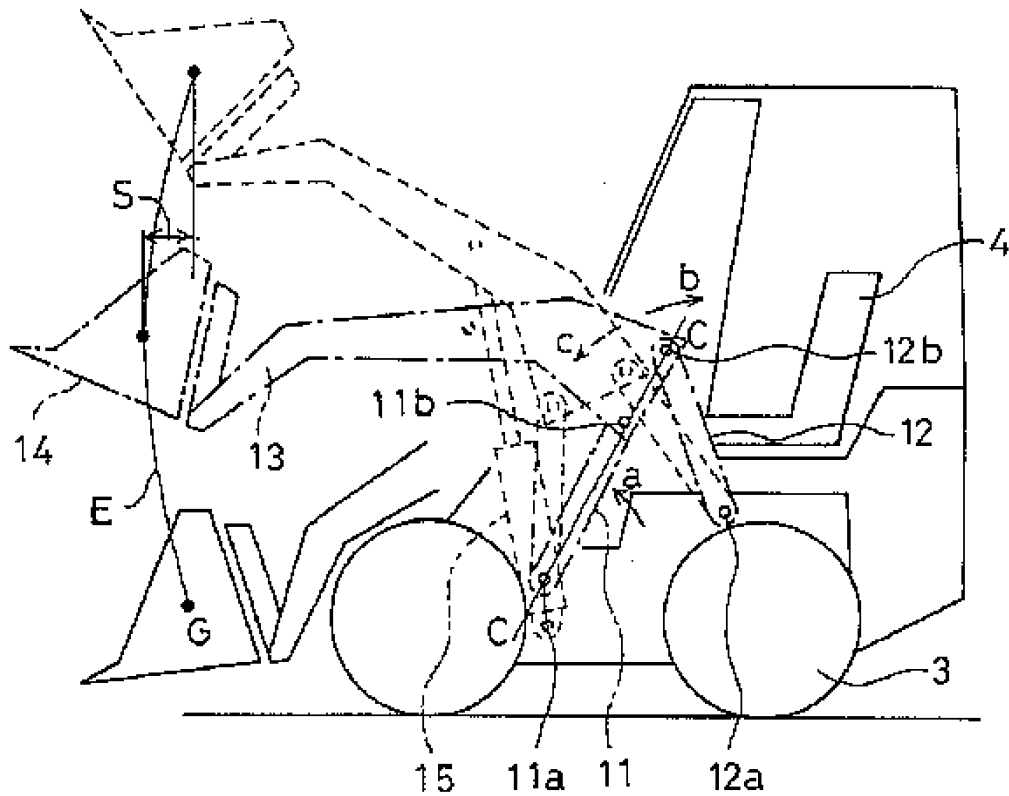


[Figure 4]
Perspective view illustrating third attachment example of
lifting cylinder



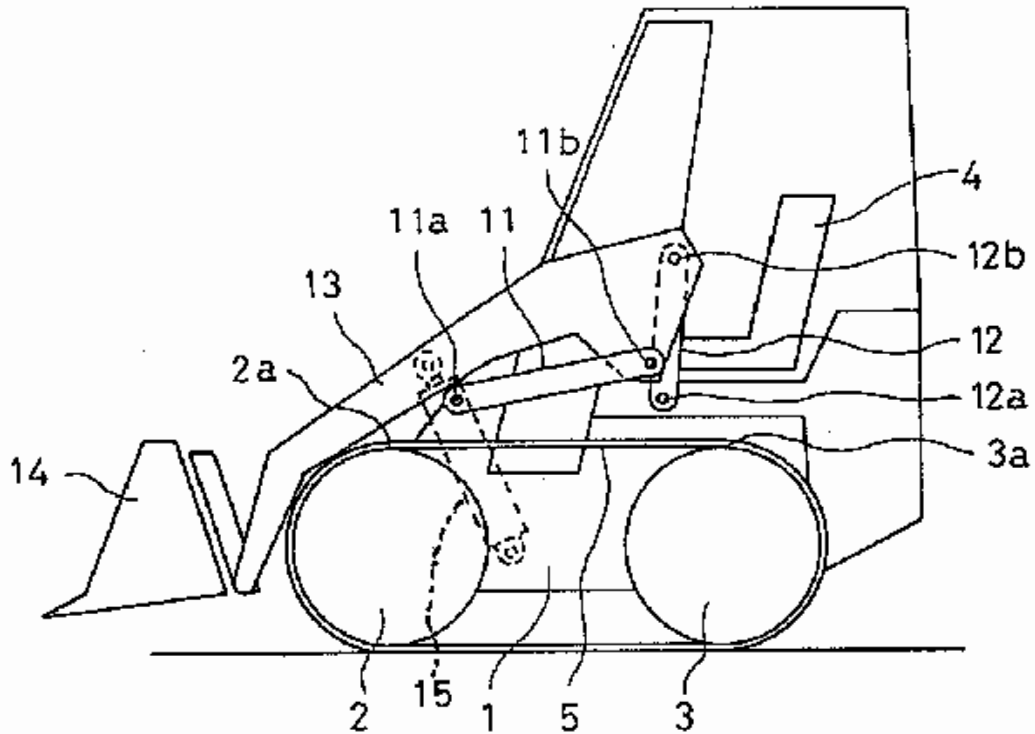
[Figure 5]

Explanatory view of operation of first exemplary embodiment



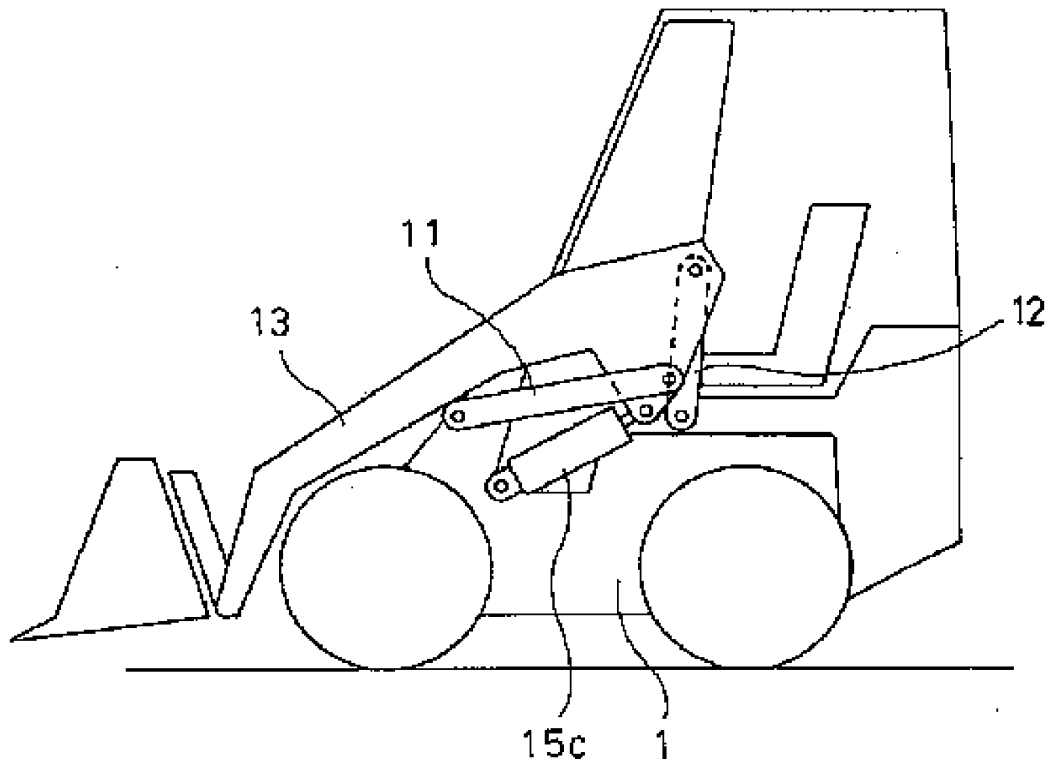
[Figure 6]

Side elevation of work vehicle provided with a four-joint link in a second exemplary embodiment



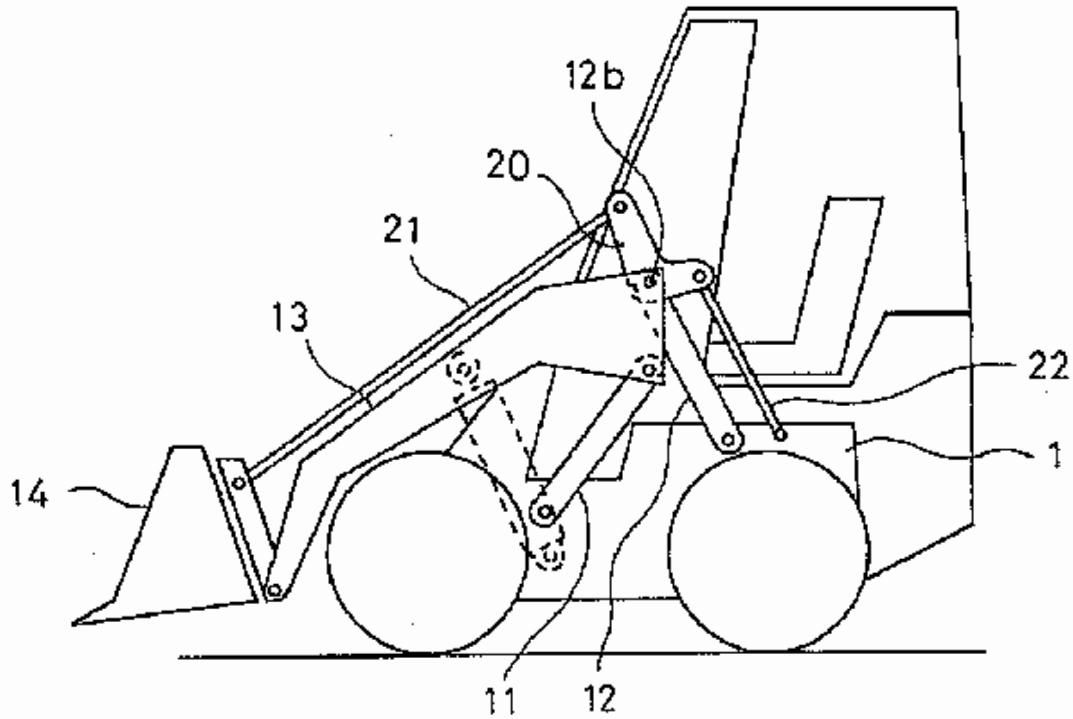
[Figure 7]

Side elevation of work vehicle provided with a four-joint link in a third exemplary embodiment



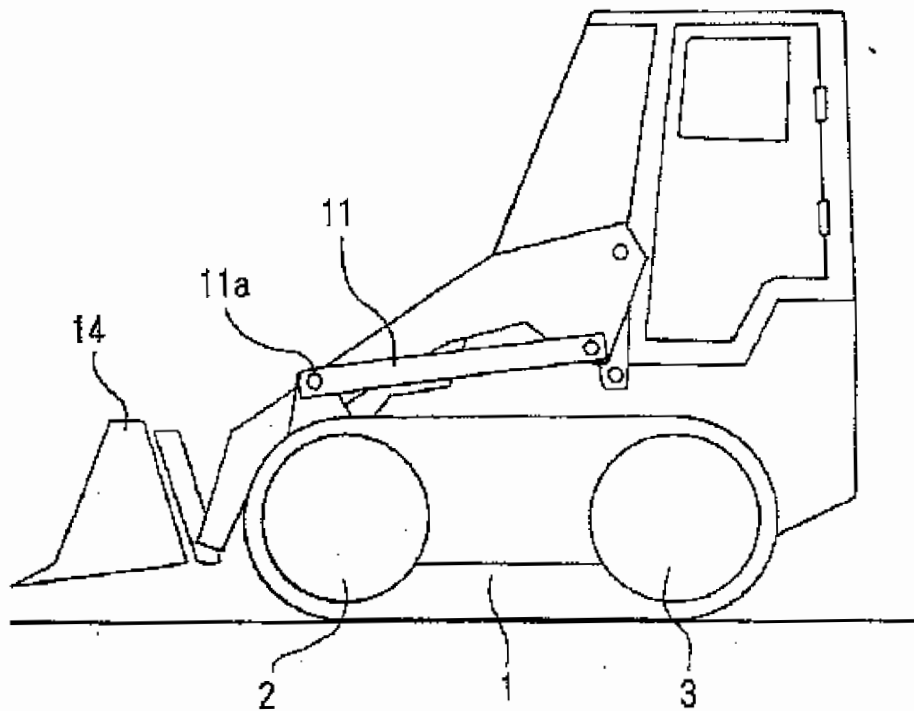
[Figure 8]

Side elevation of work vehicle provided with a four-joint link in a fourth exemplary embodiment



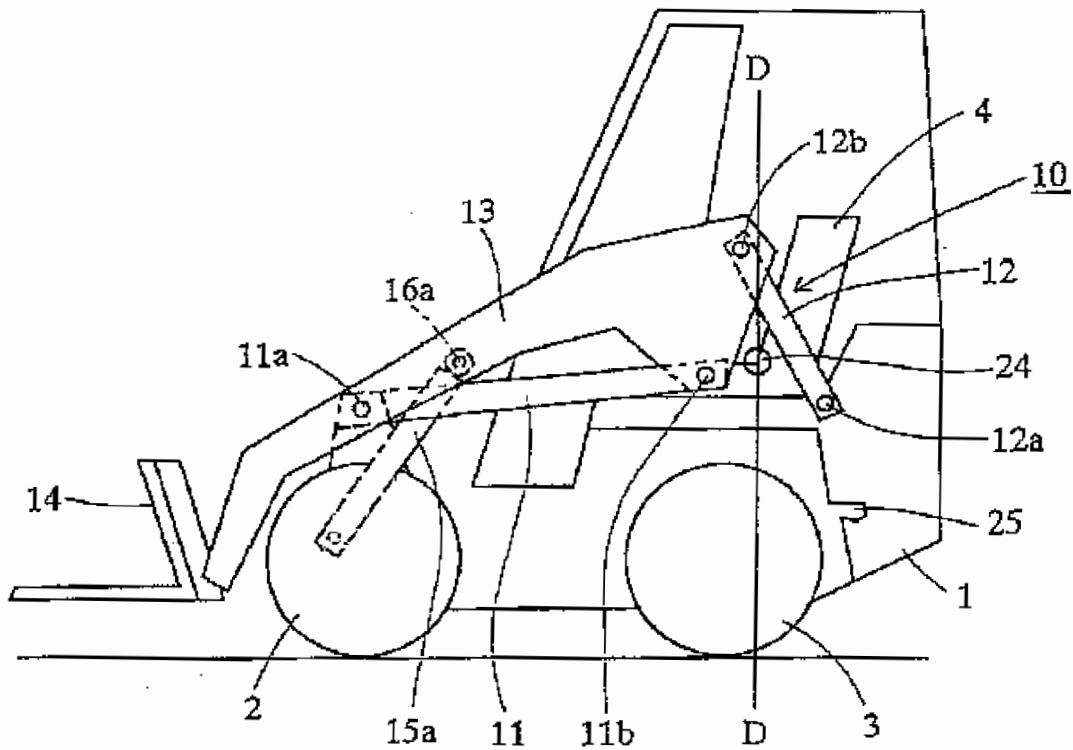
[Figure 9]

Side elevation of work vehicle provided with a four-joint link in a fifth exemplary embodiment



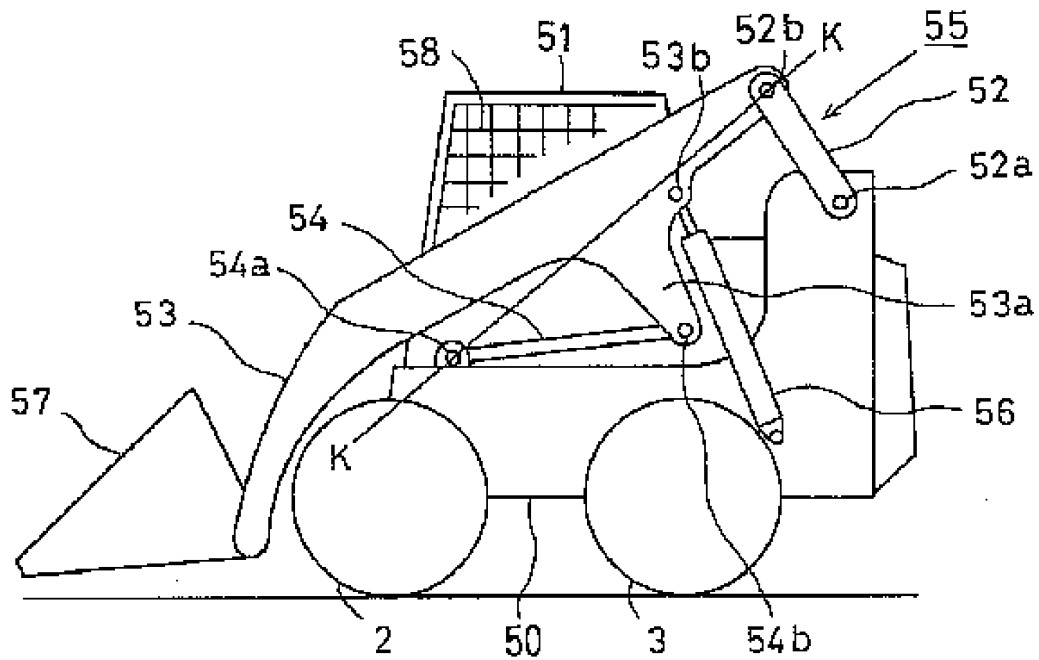
[Figure 10]

Side elevation of work vehicle provided with a four-joint link in a sixth exemplary embodiment



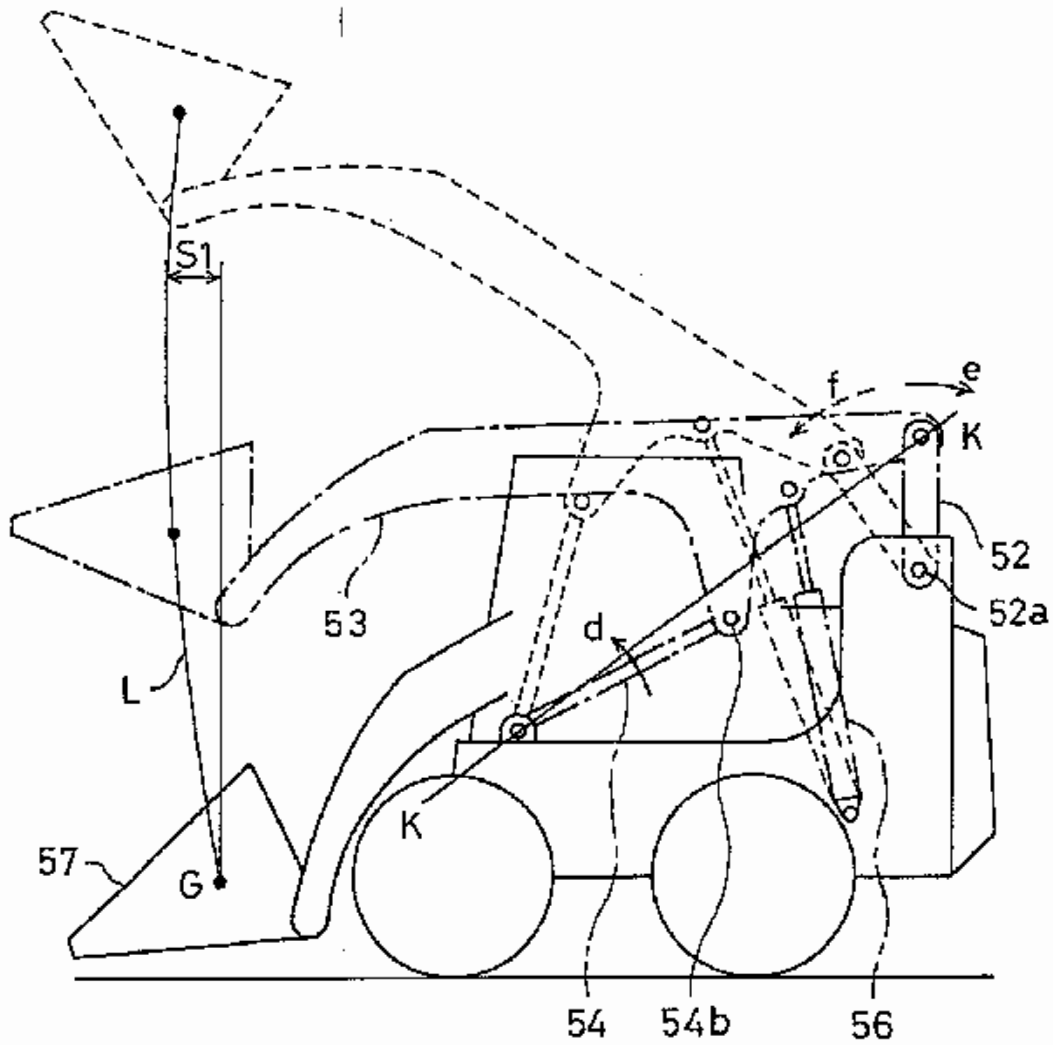
[Figure 11]

Side elevation of loading machine provided with a first example of a conventional four-joint link



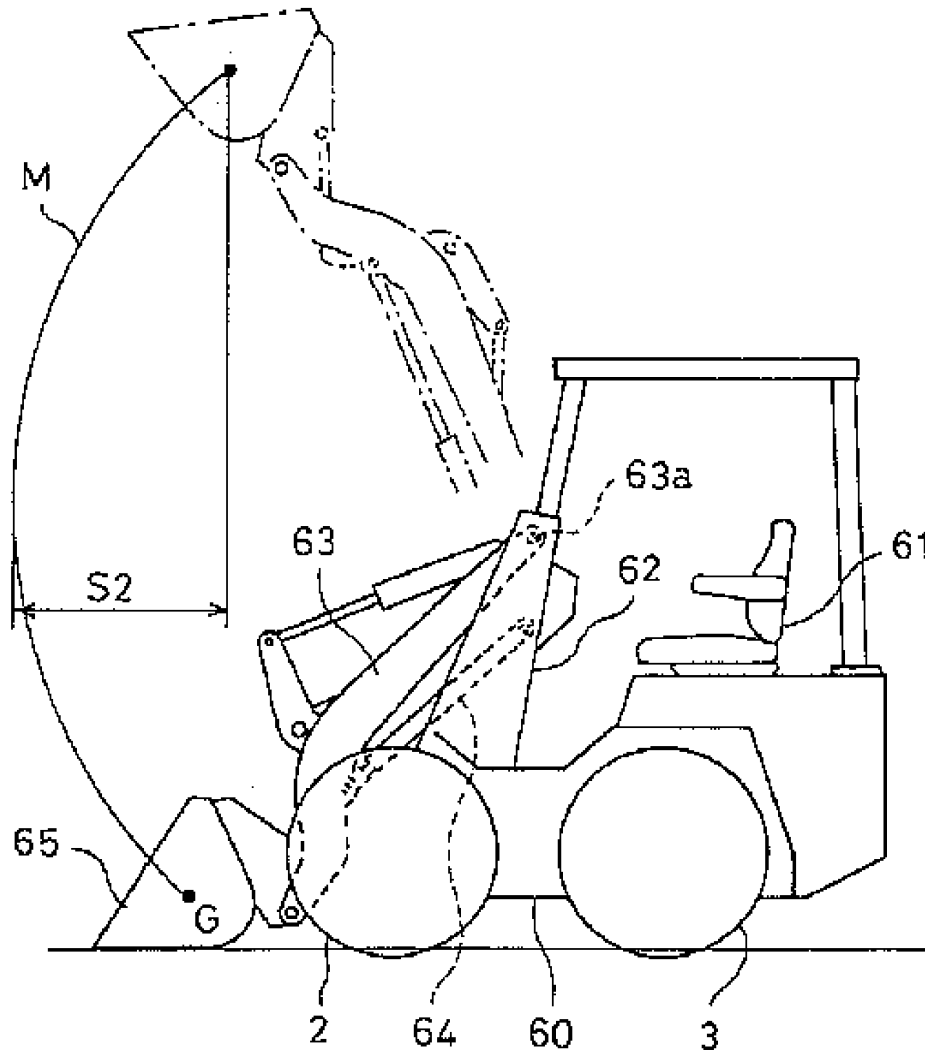
[Figure 12]

Explanatory view of operation of loading machine in Figure 11



[Figure 13]

Side elevation of loading machine provided with a second example of a conventional four-joint link



Customer Feedback

Identify customers from whom feedback was received. Explain in detail the specific feedback the customers provided. Describe the actions that will be taken to respond to the feedback.

- TX 1000 traction controls
 - Final controls were a result of all input on previous control iterations
 - Control design is ideal for various requirements of ride-on CULs
 - Easily drive machine with one hand (preferred for ride-on units)
 - Ideal for turning, particularly tight spin turns
 - Ideal for driving backwards – easy to drive the unit in a straight line when needed
 - Control design/ergonomics
 - Effortless, simple, no strain
 - Can easily operate the unit without grasping the control
 - Reference bars
 - Positioned nicely in relation to control
 - Can use palm or fingertips on control while using reference bar for stability



4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 2 / 3

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Customer Feedback

Identify customers from whom feedback was received. Explain in detail the specific feedback the customers provided. Describe the actions that will be taken to respond to the feedback.

- Additional customer input on initial 3.0 machines
 - Noted that machine felt underpowered with the D902
 - Unit easily stalled out
 - Unit seemed excessively strained
 - Unit was slower than preferred for most customers
- The subsequent change to the D1305 engine addressed and resolved the issues identified above



4.0 Mid-Development Entrance Gate



W298: Next Gen TX

Detail 3 / 3

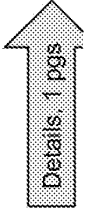
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REDACTED

4.0 Mid-Development Entrance Gate

W298: Next Gen TX



2/20/2016 8:10:43 AM 12

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000940

REDACTED

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 1 / 1

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CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000941

Prototype Plan and Results

Describe the plan and the estimated schedule for prototypes to be built and tested. Report results of prototypes that have been built.

- 3.0 Testing summary
 - Field Test Narrow Track went 82 hours in the field. Issues with track retention, loader arm strength lack of power and a muffler failure caused this testing to be stopped in early November.
 - Field Test Wide track went 224 hours in the field . Weather, engine power and loader arm strength were issues during Testing.
 - Initial Heat test was completed with the Kubota 1305.
 - Performance of the modified hydraulic system was evaluated with the auger drive and found to be acceptable

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Details: 4 pgs

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TORO-0000942

Prototype Plan and Results

Describe the plan and the estimated schedule for prototypes to be built and tested. Report results of prototypes that have been built.

- 4.0 testing planned
 - 4.0 testing is planned to be completed after first production
 - Two units to 500 hours. attempt to average 35 hours/week= 14.3 weeks start date of 2/16/15

Attempted	35 hrs/week	14.3 weeks	5/26/15
6 days/week	30 hrs/week	16.7 weeks	6/11/15
Normal plan	25 hrs/week	20 weeks	7/3/15

- Heat test will be done with Kubota data points included and will be done with 50/50 mix per Kubota procedure. Normal Toro procedure is with water.
- Lab durability test 1000 hours 10 weeks. 5/5/15
- Lab component durability test of the traction controls using a dust box planned to evaluate production tooled parts

Prototype Plan and Results

Describe the plan and the estimated schedule for prototypes to be built and tested. Report results of prototypes that have been built.

- Lab Loader arm cycle test to start this week, 50,000 cycles (4 weeks).



- Stability, Tip capacity, Hot Surface, Sound and vibration testing to be done using pilot units or other non-test 4.0 prototypes when available.
- Safety Testing per ISO 20474, EN 474, SAE 2752

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 2 / 4

2/20/2015 8:13:10 AM 16

TORO-0000944

Prototype Plan and Results

Describe the plan and the estimated schedule for prototypes to be built and tested. Report results of prototypes that have been built.

- Attachment Performance evaluation- Dingo attachments to evaluate their effect on the traction unit and the effect of the increase lift and height on the attachment.
- New Bucket Stress evaluation
- Other testing that may be delayed until late in the 4.0 test schedule includes Fork and Leveler cycle testing with the heavier TX 1000 loading.

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 3 / 4

2/20/2015 8:10:10 AM 17

TORO-0000945

Prototype Plan and Results

Describe the plan and the estimated schedule for prototypes to be built and tested. Report results of prototypes that have been built.

5.0 Stage

- Two pilot preship units (1NT, 1 WT) tested to 100 hours
- Two production preship units tested to 50 hours

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 4 / 4

2/20/2015 8:13:10 AM 16

TORO-0000946

Sourcing Plan and Readiness

Explain the sourcing plan for this product. Identify the critical components and the suppliers. Explain how and why they are selected. Describe their performance and ability to achieve the critical quality, delivery and cost

Sourcing Plan and Readiness Project: W298 Next Gen TX - Tmax		Stage Gate: 4.0 Mid-Development 01/05/2015			
Critical Processes (Color code based on status)	Status	Comments (Critical concerns/Action plans)		Background Information	
Green= On schedule to meet target, no problems foreseen Yellow=Some concerns about meeting target Red=Target not attainable at this time, action needed					
Application Reviews		Application Reviews are identified in the Advanced Quality Plan. The Advanced Quality Plan has not identified any Application Reviews to date.		Application reviews are identified by the Advanced Quality Plan.	
New suppliers and justification		There are no new suppliers.		New suppliers are added per the New Supplier Add Process.	
Sole sourced components		Sole sourced suppliers are REDACTED		Identify parts awarded to a supplier that would take more than one year to re-source	
Single sourced components		Single sourced components are: REDACTED		Identify parts awarded to a supplier that are hard tooling or proprietary which would be difficult to move or replace	
Restricted / Probation Suppliers		REDACTED are Restricted Suppliers. The Sourcing Quality Engineer is working with each supplier to get their status back to approved.		It is Toro's policy to not offer any new business opportunities with those suppliers placed on Probation status and limit opportunities for those on Restrictive.	
Cost savings / avoidance activities		No cost savings/avoidances identified at this time.		Report cost savings activities during the project.	

Details, 2 pgs

2/20/2016 8:10:10 AM 13

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

*Highlighting Added = CONFIDENTIAL ATTORNEYS' EYES ONLY

TORO-0000947

Sourcing Plan and Readiness

Explain the sourcing plan for this product. Identify the critical components and the suppliers. Explain how and why they are selected. Describe their performance and ability to achieve the critical quality, delivery and cost

Sourcing Plan and Readiness (Cont.)		Stage Gate: 4.0 Mid-Development	Background Information
Project: W298 Next Gen TX - Tmax			
Critical Processes (Color code based on status)	Status	Comments (Critical concerns/Action plans)	Target
Green= On schedule to meet target, no problems foreseen Yellow=Some concerns about meeting target Red=Target not attainable at this time, action needed			
Lead-time		There are no lead-time issues at this time.	Identify critical long lead-time new purchased parts. (i.e. tooling or global sourced)
Part Count		The total part count is supplied by the AME in the DFMA Plan and Metrics Slide	New part numbers and total part count.
Total Cost Model		There are no parts identified that need the total cost model used at this time.	Identify if and how many parts have used the Total Cost Model Process (TCM).
Supplier Capacity Constraints		No Capacity Constraints are known at this time.	Identify critical components that may have capacity constraints
Sourcing challenges or concerns		There are no sourcing concerns at this point.	Identify concerns that should be noted during the gate meeting

Detail 1 / 2

W298: Next Gen TX

4.0 Mid-Development Entrance Gate

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TORO-0000948

Sourcing Plan and Readiness

Explain the sourcing plan for this product. Identify the critical components and the suppliers. Explain how and why they are selected. Describe their performance and ability to achieve the critical quality, delivery and cost targets.

Sourcing Plan and Readiness (Cont.)		Stage Gate: 4.0 Mid-Development					
Project: W298 Next Gen TX - Tmas		Updated: 01/05/2015					
Critical Suppliers							
Company	Part Description	SPE	PPM	Delivery	ASL Status	Comments	
REDACTED	Cylinder	80.5	3,675	25	Restricted	Grow	
	Control Valves	64.18	6,999	25	Restricted	Maintain	
	Gear Pump	85.5	1,918	25	Approved	Maintain	
	Track	97.06	0	25	Approved	Grow	
	Tandem Pump	100	0	25	Approved	Maintain	
	Pump Mount Asm	71	5,748	25	Approved	Maintain	
	Engine	100	0	25	Approved	Maintain	
	Wheel Motor	86	2,669	25	Restricted	Maintain	

Detail 2 / 2

W298: Next Gen TX

4.0 Mid-Development Entrance Gate

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TORO-0000949

Advanced Quality Plan

Summarize the status of the key components and suppliers for this product.

Quality Plan	Status	Plan			
3.0 Machine Risk Assessment	Complete (Initial Risk Determined)	Key Components/Assemblies			
			3.0	4.0	5.0
		High	31	25	---
		Moderate	35	33	---
Advanced Quality Plan	In Process (Due by Pilot)	Key Components/Assemblies			
		•Engine •Lift system •Hydraulic Motors •Frame •Drive wheels	•Hydraulic Pump •Muffler •Fuel Tank •Operator Controls •Tracks •Parking Brake		
Application Reviews	In Process (Due by Prod)	12 Planned			
Validation Audit Plan	In Process (Due by Release)	2 Pilot, 2 Production			
Validation Pre-Ship Plan	In Process (Due by Release)	2 Pilot (100hr Min), 2 Prod (50hr Min)			

4.0 Mid-Development Entrance Gate

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TORO-0000950

Production Plan and Readiness

Explain the plan for producing this product. Identify the production locations, why that location is the best choice, and how the ramp-up to production will occur. Describe the line changes and major equipment required.

Pilot Manufacturing Readiness Scorecard					Background Information	
Project: TX-1000 (22327.22328)					Current Est. Pilot 3/17/15	
Updated:						
Color Code	Critical Processes (Color code based on status)		Status	Comments (Critical concerns/action plans)	Champion	Target
	Green-On Schedule no concerns at this time	Yellow-Some concerns about meeting target				
Resources			Pilot run is currently scheduled on line 15 starting 3/17/15. (3) wide and (3) narrow		Plant Manager	Resources identified and available for production and support operations three months before Pilot
	Plan for first full production established		1st production is currently scheduled for 4/20/15. (40) wide, (10) narrow		Plant Manager	Complete before Pilot begins
	All component tooling ordered		All tooling ordered		AME	Ordered per lead time requirements
Component Tooling	Weld, die cast, stamping, and injection molded tooling built		Weld tooling in process - delivery will be close due to late releases		AME	Completed two weeks (per lead time) before Pilot
	Weld, die cast, stamping and injection molded tooling qualified		not started yet		Plant M.E./AME	Part qualified on production equipment one week before Pilot
Assembly Fixtures	Assembly tooling and fixtures ordered				Plant M.E.	Ordered per lead time requirements
	Identified assembly tooling and fixtures built		Some complete, currently working on a loader arm assy tool		Plant M.E.	Completed and functional before Pilot begins
Pilot	Pilot Review		In process		Plant M.E.	Complete before Pilot begins

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Details, 1 pgs

2/20/2015 8:10:10 AM 23

TORO-0000951

Production Plan and Readiness

Explain the plan for producing this product. Identify the production locations, why that location is the best choice, and how the ramp-up to production will occur. Describe the line changes and major equipment required.

Pilot Manufacturing Readiness Scorecard			Current Est. Pilot 3/17/15	Background Information	
Project: TX-1000 (22327,22328)	Updated:	130-7732, P.O. revised 1/16, loading 3/27, vendor is starting mid April. Cansepa pumps are also a concern.		Materials Supervisor	Storage meetings will verify all parts are available at the correct revision one week before Pilot.
Incoming Parts	Parts Availability				
Mfg. Processes	Completed production assembly process and visual aides	25% complete, waiting on drawings		Plant M.E.	Complete before Pilot begins.
	Critical torque requirements documented in assembly process, tools available	Waiting for specs.		Plant M.E.	Complete before Pilot begins.
	Safety Review and Training	In process		Plant M.E.	Complete before Pilot begins.
	Manufacturing Inspection Plans			Plant Quality	Complete before Pilot begins.
	Installation of Plant Capital Equipment	Complete		Plant M.E.	Operational for Pilot.
Other requirements	Final Assembly notes and drawings complete. (includes packaging)	In process, due date is 2/10/15		Eng. Project Lead/AME	Complete per the Pilot Standard 5 weeks.
	Testing			Test	Complete per the Test Plan prior to Pilot.
	Cost Rolls and Routings complete			Cost Est.	Complete before Pilot begins.
	Key Components received with certificate of conformance and approved			AOE	Received with parts.
	Certificate of Origin Documents			Sourcing	Received from each supplier before parts can be imported.

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 1 / 1

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TORO-0000952

Regulatory and Compliance Readiness

List all Agency, Regulatory and Compliance standards which the product must satisfy. Include both voluntary and mandatory requirements need for sales success in the target markets. Explain the current status of approval for each standard and note what remains to be completed, by when and by whom.

REDACTED

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

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TORO-0000953

Market Launch Plan and Readiness

List the tasks required for successful market launch. Identify actions as planned or completed. Address all relevant aspects, including programs, marketing communications, obsolete products, training, field service, inventory positioning, etc.

- TX 1000 product training and education
 - SWS Sales Meeting January 20-21, Lyndale
 - Completed full product review, and entire Sales team operated product
 - TRB/DOB distribution February 10
 - Full product summary and review, including pricing
 - First public disclosure
 - Dealer webcast February 10
 - Full product review for all SWS dealers
 - Rental Rep product training February 21-22, New Orleans
 - Product walk-around, features and benefits review, product demo
 - Goal is to familiarize Rental Reps with the product in advance of the ARA Show
 - Dealer Training April 13-15, Lyndale and Appleside
 - Full product review, marketing programs review, and demo at Appleside

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Details: 6 pgs

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TORO-0000954

Market Launch Plan and Readiness

List the tasks required for successful market launch. Identify actions as planned or completed. Address all relevant aspects, including programs, marketing communications, obsolete products, training, field service, inventory positioning, etc.

- TX 1000 Marketing and launch plan
 - Plans identified for both the Dealer and Rental channels

TX 1000 Launch Activities

Category	Activity	Status / date planned	Notes:
PM/Agency	Performance - TX 1000 PR and Messaging	In process	Performance Marketing: TX 1000 PR and Messaging work etc.
Photobooth	TX 1000 Studio photography	Complete	Photo editing
Photovideo	TX 1000 Video and still photography	Complete	TX 1000 and full Dingo line-up videos
Transitions	Booth assets - touch screen	In process	Interactive monitors
Transitions	Booth assets - product pedestal	In process	
Training	ARA Rep training	February	
Advertising	Rental Management - March issue	March	Full page ad, this issue highlights post-show news
Advertising	Compact Equipment - March issue	March	Full page ad, Compact Tool Carrier issue
Email blast	Post-ARA Rental store email blast	March	
TRBS/DOBS/Webcasts	TX 1000 educational info	February-June	Consistent educational info around TX 1000
Training	Commercial Dealer training	April	
Toro.com	Website updates	April/May	TX 1000 photography and video
Toro.com	Banner announcement	April/May	
Literature	Dingo TX 1000 sell sheet	In process	
Literature	Updated Rental Guide	In process	Updated guide to include TX 1000 units
Literature	Full line Dingo brochure	April	Performance Marketing editing and formatting
Literature	Attachment guide brochure	April	
Direct mail	Rental direct mail	May	
Advertising	Lawn and Landscape - May issue	May	Full page ad, Mini-track loaders issue
Direct mail	Dealer direct mail	May	UCC list last 3 years, 3500 names.
Direct mail	Dealer direct mail	May	Toro Warranty Registration list last 5 years, 4000 names
Point of Sales	POS kits	May	Poster, counter mats, window cling
Advertising	Ad Slicks for Dealers	May	
Advertising	RER - June issue	June	Full page ad
Dealer Promos	Dealer Promotion Activities	Jul - Aug	Facilitate Dealer activities/events around TX 1000

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 1 / 6

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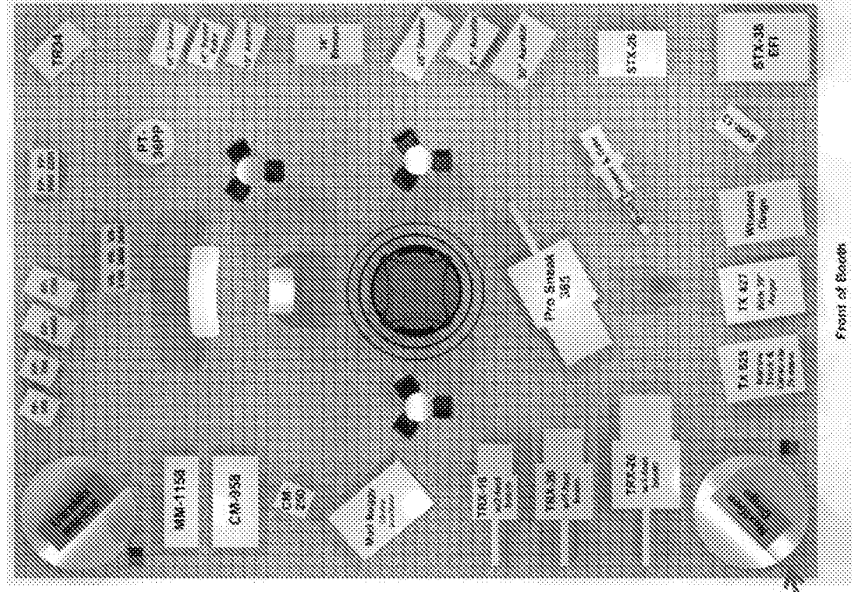
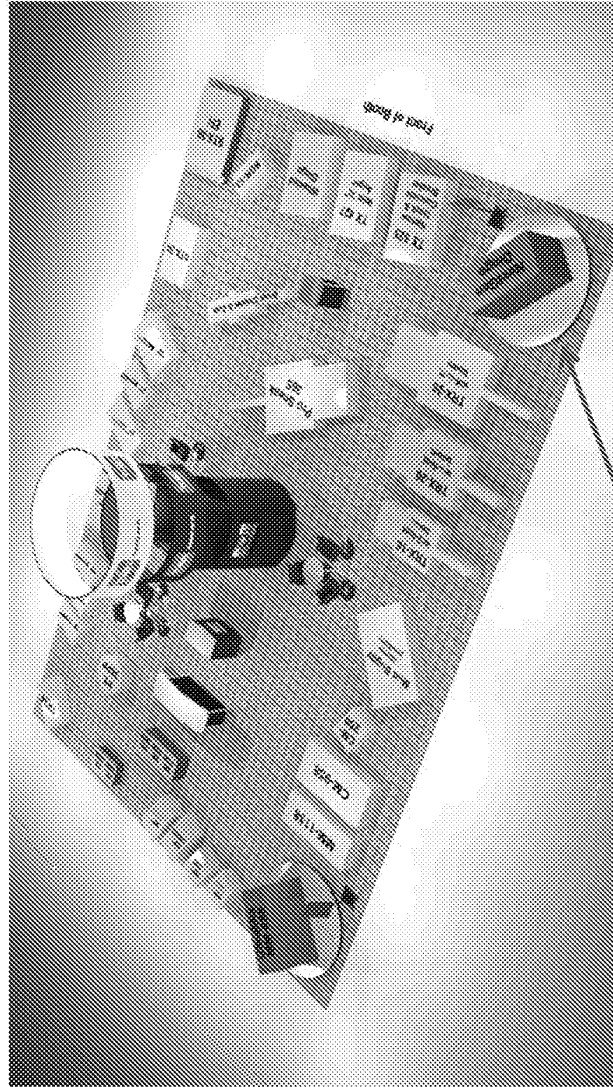
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TORO-0000955

Market Launch Plan and Readiness

List the tasks required for successful market launch. Identify actions as planned or completed. Address all relevant aspects, including programs, marketing communications, obsolete products, training, field service, inventory positioning, etc.

- ARA Show planning
 - Prominent TX 1000 display and signage at the Rental Show
 - New podium for TX 1000



4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 2 / 6

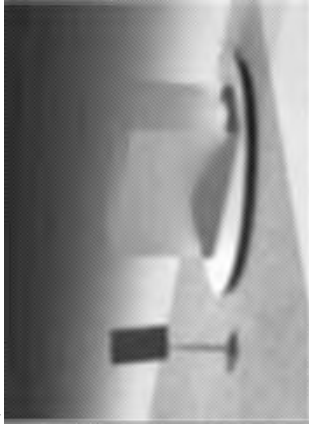
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TORO-0000956

Market Launch Plan and Readiness

List the tasks required for successful market launch. Identify actions as planned or completed. Address all relevant aspects, including programs, marketing communications, obsolete products, training, field service, inventory positioning, etc.

- ARA Show planning
 - Project Siena display touch screens
 - Interactive monitors
 - Access to videos and photos, literature, specs
 - Link to pdf literature of new sell sheets
 - PR and Press Conference
 - Scheduled launch to the media



4.0 Mid-Development Entrance Gate



W298: Next Gen TX

Detail 3 / 6

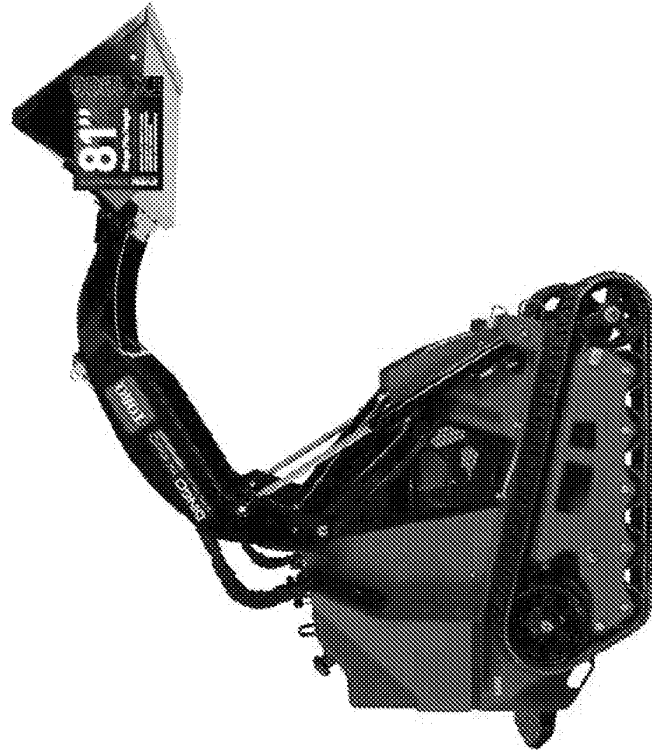
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TORO-0000957

Market Launch Plan and Readiness

List the tasks required for successful market launch. Identify actions as planned or completed. Address all relevant aspects, including programs, marketing communications, obsolete products, training, field service, inventory positioning, etc.

- ARA Show planning
 - 8' display tower (4-sided, 2ft wide) with graphics will be positioned near the TX 1000
 - Signage on product for key feature callouts



4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 4 / 6

2/20/2015 8:10:10 AM 30

TORO-0000958

Market Launch Plan and Readiness

List the tasks required for successful market launch. Identify actions as planned or completed. Address all relevant aspects, including programs, marketing communications, obsolete products, training, field service, inventory positioning, etc.

- ARA Show and launch planning
 - TX 1000 videos designed to engage viewers
 - Overview is 1 minute, feature videos are about 45 seconds each
 - TX 1000 videos will be utilized on Toro.com and YouTube
 - TX 1000 videos are complete
 - #1 Product overview
 - #2 Vertical Lift Loader Arms
 - #3 High Drive Track System
 - #4 Easy to Use
 - #5 Efficiency and Maintenance



4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 5 / 6

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TORO-0000959

Market Launch Plan and Readiness

List the tasks required for successful market launch. Identify actions as planned or completed. Address all relevant aspects, including programs, marketing communications, obsolete products, training, field service, inventory positioning, etc.

- Literature and creative
 - Artwork and copy for planned advertisements is finalized
 - Sell sheet is nearly complete
 - New catalog creation is in process



4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 8 / 6

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TORO-0000960

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4.0 Mid-Development Entrance Gate

W298: Next Gen TX

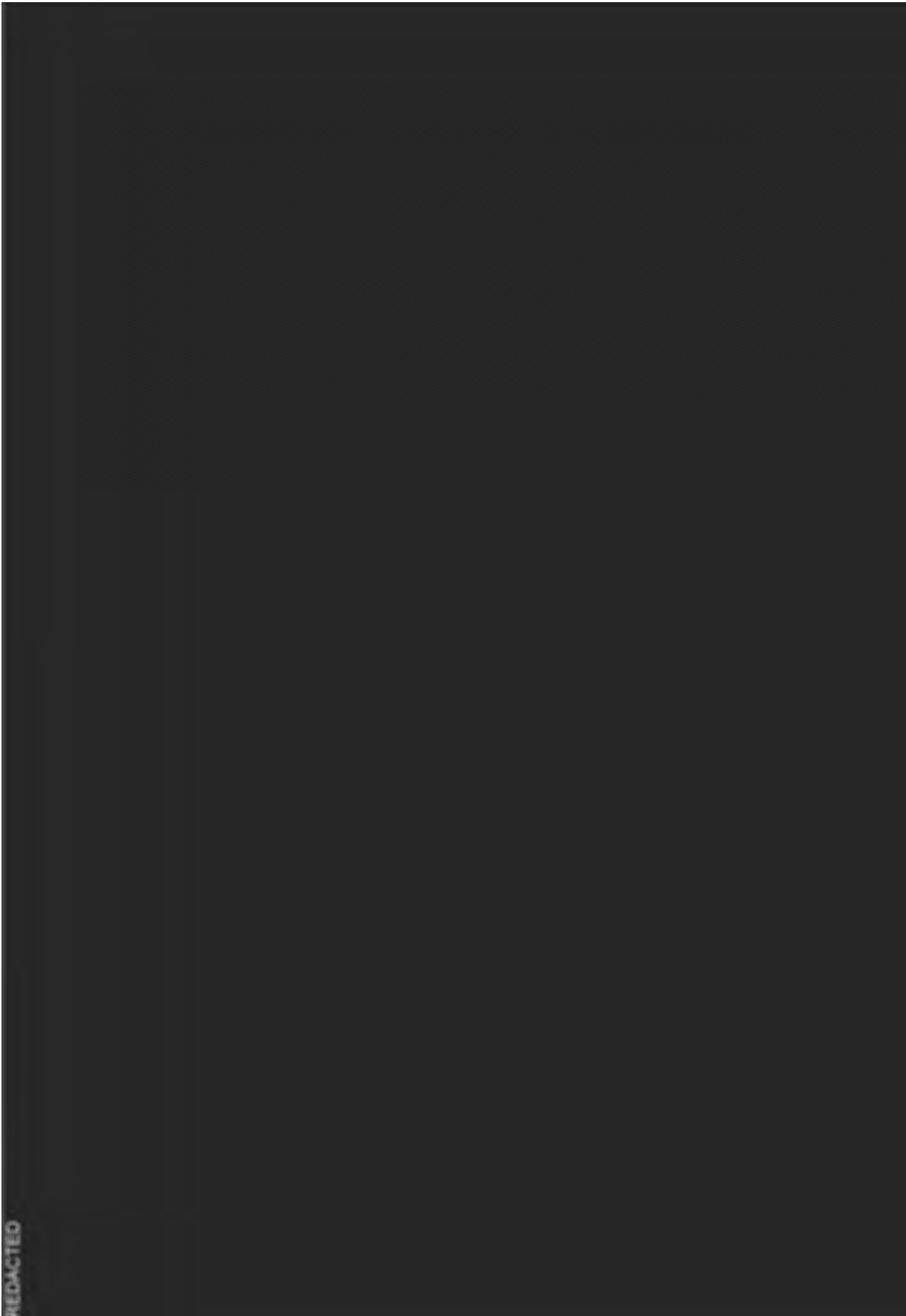
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Navigation & TOC view 39

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TORO-0000961

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4.0 Mid-Development Entrance Gate

W298: Next Gen TX

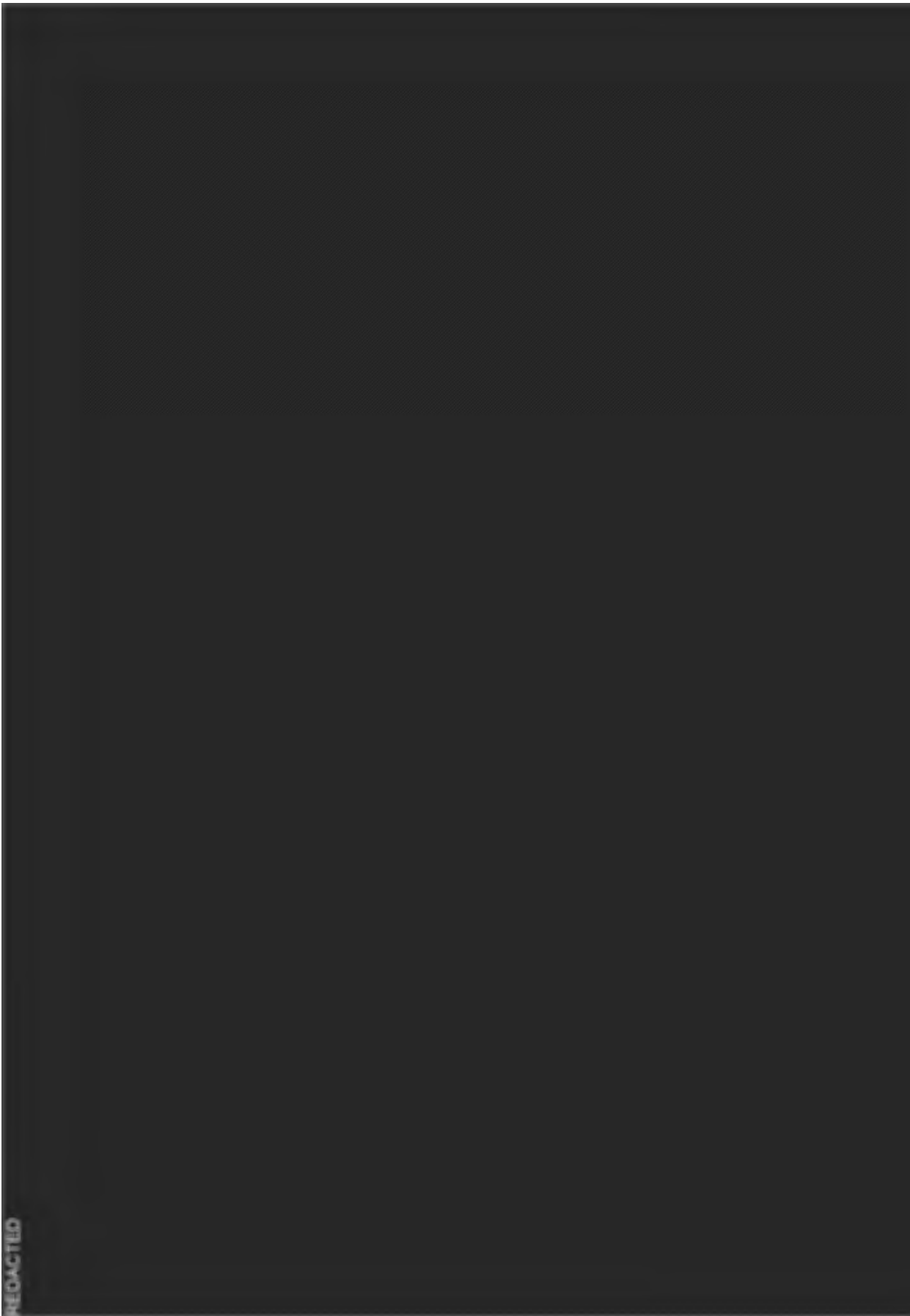
Detail 1 / 4

2/20/2015 8:10:10 AM 34

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TORO-0000962

REDACTED



4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 2 / 4

2/20/2015 8:10:10 AM 35

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TORO-0000963

REDACTED

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 3 / 4

2/20/2015 8:10:10 AM 36

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TORO-0000964

REDACTED

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 4 / 4

2/20/2015 8:10:10 AM 3/7

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TORO-0000965

Projected Annual Quantity

Project the annual quantity expected to be sold in the next five years, for each model, domestic and international. Note if presented in units or thousands of units. Values are considered estimates until the Development Gate is approved, when then become measures of performance.

Model / SKU#	Description	FY1 2015	FY2 2016	FY3 2017	FY4 2018	FY5 2019
Domestic						
22327	Dingo TX 1000 Narrow Track	103	171	242	294	334
22328	Dingo TX 1000 Wide Track	216	456	517	578	636
	Total	319	627	759	872	970
International						
22327	Dingo TX 1000 Narrow Track	7	12	15	18	23
22328	Dingo TX 1000 Wide Track	18	25	29	35	41
	Total	25	37	44	53	64

4.0 Mid-Development Entrance Gate

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TORO-0000966

Project Investment

Estimate the project investment by fiscal year and by phase. Update projections and actual at each Gate.

Project Investment by Phase						
Dollars in Thousands (\$,000.)	Concept Phase	Feasibility Phase	Development Phase	Mid-Development Phase	Mfg Pilot Phase	Total
Engineering						
Original Estimate		665	849	145	118	1,777
Current Projection				189	114	2,075
Actual		665	1,107			1,772
Variance			258	44	(4)	298
Tooling						
Original Estimate			150	100	100	350
Current Projection			150	100	170	420
Actual						
Variance					70	70
Marketing						
Original Estimate			50	75	75	200
Current Projection				100	50	150
Actual						
Variance			(50)	25	(25)	(50)
Other						
Original Estimate						
Current Projection						
Actual						
Variance						
Total		665	1,049	320	293	2,327
Original Estimate						Original Estimate
Current Projection			150	389	334	2,645
Actual		665	1,107			1,772
Variance			208	69	41	318
						Variance

* Actual spending is through January 2014

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Details: 1 pgs

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TORO-0000967

Project Investment

Estimate the project investment by fiscal year and by phase. Update projections and actual at each Gate.

Project Investment by Fiscal Year						
<i>Dollars in Thousands</i>						
Fiscal Year	2013	2014	2015	2016	2017	Total
Engineering	\$ 512	\$ 955	\$ 608			\$ 2,075
Tooling		\$ 250	\$ 170			\$ 420
Marketing		\$ -	\$ 150			\$ 150
Other						\$ -
Total	\$ 512	\$ 1,205	\$ 928	\$ -	\$ -	\$ 2,645

*Added spending was mainly in 2015 because of the extension of the project due to the engine change

REDACTED

4.0 Mid-Development Entrance Gate

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TORO-0000969

Project Schedule and Milestones

List the milestones and dates that are critical to achieve the planned project schedule.

Milestone Dates	3.0 Plan	Actual / 4.0 Update	Comments
2.0 Approval	3/11/13	3/11/13	
2.0 Prototype Build Completed	10/7/13	10/7/13	
3.0 Signoff	2/17/14	2/17/14	
3.0 Prototype Build Completed	5/27/14	7/23/14	
3.5 Update	6/23/14	11/3/14	DR to change to D1305 engine
Long Lead / Tooling Releases	9/25/14	11/19/14	Major weldments and castings released here
4.0 Signoff	10/15/14	1/30/15	
4.0 Updates (build)	10/29/14	2/3/15	In process; all weldments now complete
5.0 Signoff	1/5/15	3/9/15	
Pilot Build Start	1/14/15	4/14/15	
Production Start	3/12/15	5/26/15	
Release to Ship	3/19/15	6/16/15	
500 hours complete on 4.0's	3/18/15	6/11/15	See Test Plan for details

4.0 Mid-Development Entrance Gate **W298: Next Gen TX**

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TORO-0000970

Mid-Development Phase Actions

List the most critical actions the team needs to complete in the Mid-Development Phase for this project to fully satisfy the stated project objectives.

- Engineering
 - Finish 4.0 build
 - Finish final releases
 - React to field and lab issues
 - Complete Risk assessments
 - Complete application reviews, including Kubota approval
 - Marketing support for Rental Show
 - Attachment work
 - 3 skus assigned for 2 new buckets and strengthened forks
 - Buckets samples are being welded now; more work is required on the forks
 - Backhoe will not initially be available for this unit without some kind of adapter kit

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Details, 2 pgs

2/20/2015 8:10:10 AM 43

TORO-0000971

Mid-Development Phase Actions

List the most critical actions the team needs to complete in the Mid-Development Phase for this project to fully satisfy the stated project objectives.

Marketing

- Successful debut at ARA (Rental) Show
- Complete effective demo product training and webcasts to our Channel partners
- Provide effective TX 1000 launch materials and effectively communicate the planned marketing activities to our Channel

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 1 / 2

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TORO-0000972

Mid-Development Phase Actions

List the most critical actions the team needs to complete in the Mid-Development Phase for this project to fully satisfy the stated project objectives.

- Service
 - A service manual will be developed off a pilot unit or a marketing unit after ARA
 - Service schools will likely take place in the fall

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 2 / 2

2/20/2015 8:10:10 AM 45

TORO-0000973

Project Risks and Risk Management Plan

List the risks that may limit the project from achieving the goal. Consider all aspects including: marketing, competition, distribution, quality, performance, price, design, supply, etc. For each risk state the impact, the likelihood of occurring, the mitigation actions to prevent the occurrence and the contingency plan if it occurs.

Priority	Risk	Likely To Occur	Impact	Mitigation Actions	Contingency Actions
Rank	What is the issue that may impact the project?	High Medium Low	If it occurs how will it effect the project?	What are the actions being taken to prevent the occurrence or minimize the impact?	If the Risk does occur what actions will the team take?
1	Lack of durability testing on new engine, loader, controls, and track changes	High	Unknown failure types and issues in the field	Loader arm cycle test; Control cycle test, expedited field testing; more visits to test site to monitor and jump on test issues	Review and address field issues
2	Loader arm complexity and durability results in failures	Med	Increased weight, cost, and time to develop the arm	Loader arm linkages revised for 4.0 and more iterative FEA completed; Aggressive loader cycle test in process	Revise and reinforce loader design

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Details, 1 pgs

2/20/2015 8:10:10 AM

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TORO-0000974

Project Risks and Risk Management Plan

List the risks that may limit the project from achieving the goal. Consider all aspects including: marketing, competition, distribution, quality, performance, price, design, supply, etc. For each risk state the impact, the likelihood of occurring, the mitigation actions to prevent the occurrence and the contingency plan if it occurs.

Priority	Risk	Likely To Occur	Impact	Mitigation Actions	Contingency Actions
Rank	What is the issue that may impact the project?	High Medium Low	If it occurs how will it effect the project?	What are the actions being taken to prevent the occurrence or minimize the impact?	If the Risk does occur what actions will the team take?
3	Late changes, releases, and modifications for the pilot	High	Delay pilot and production	Work with vendors to expedite parts as nec. – quickly react to Test issues	Modify and rework as nec. to achieve the production dates

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 1 / 1

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TORO-0000975

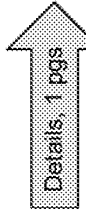
Business and Project Strategy

Explain how this new product aligns with the business strategy and product category strategy. Describe how the market strategy will optimize the sales of this new product.

- Successfully expand the Dingo product line offering with the introduction of the TX 1000 Narrow Track and Wide Track units
 - TX 1000 units were additions to the existing TX line
 - Existing 427, 525 and wheeled units have significant value, in both the dealer and rental channels
- Become the #1 Compact Utility Loader of choice for contractors and rental
 - Meet, and exceed, competitor specifications and incorporate key features
 - Greatest rated operating capacity (1000 and 1075 lbs) in the CUL category
 - 81" hinge pin height to clear 30 yard dumpsters and one ton truck with 24" sideboards
 - High drive track system
 - High max travel speed in forward (4.7 mph) and reverse (4.7 mph)
 - Intuitive and differentiated traction controls
- Re-establish Toro as the CUL market leader
 - Toro invented the category, and Toro has re-invented the category through TX 1000 product innovation
 - Vertical lift loader arm design and traction controls

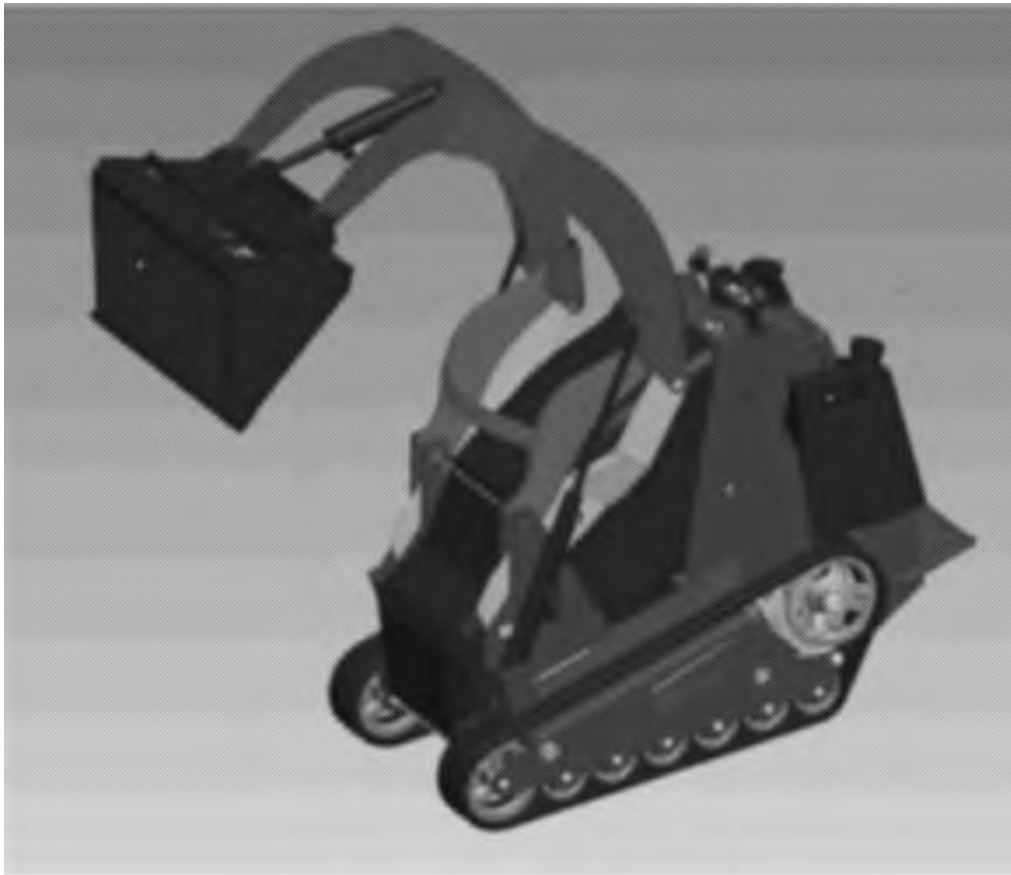
6.0 Project Close Report

W298: Dingo TX1000

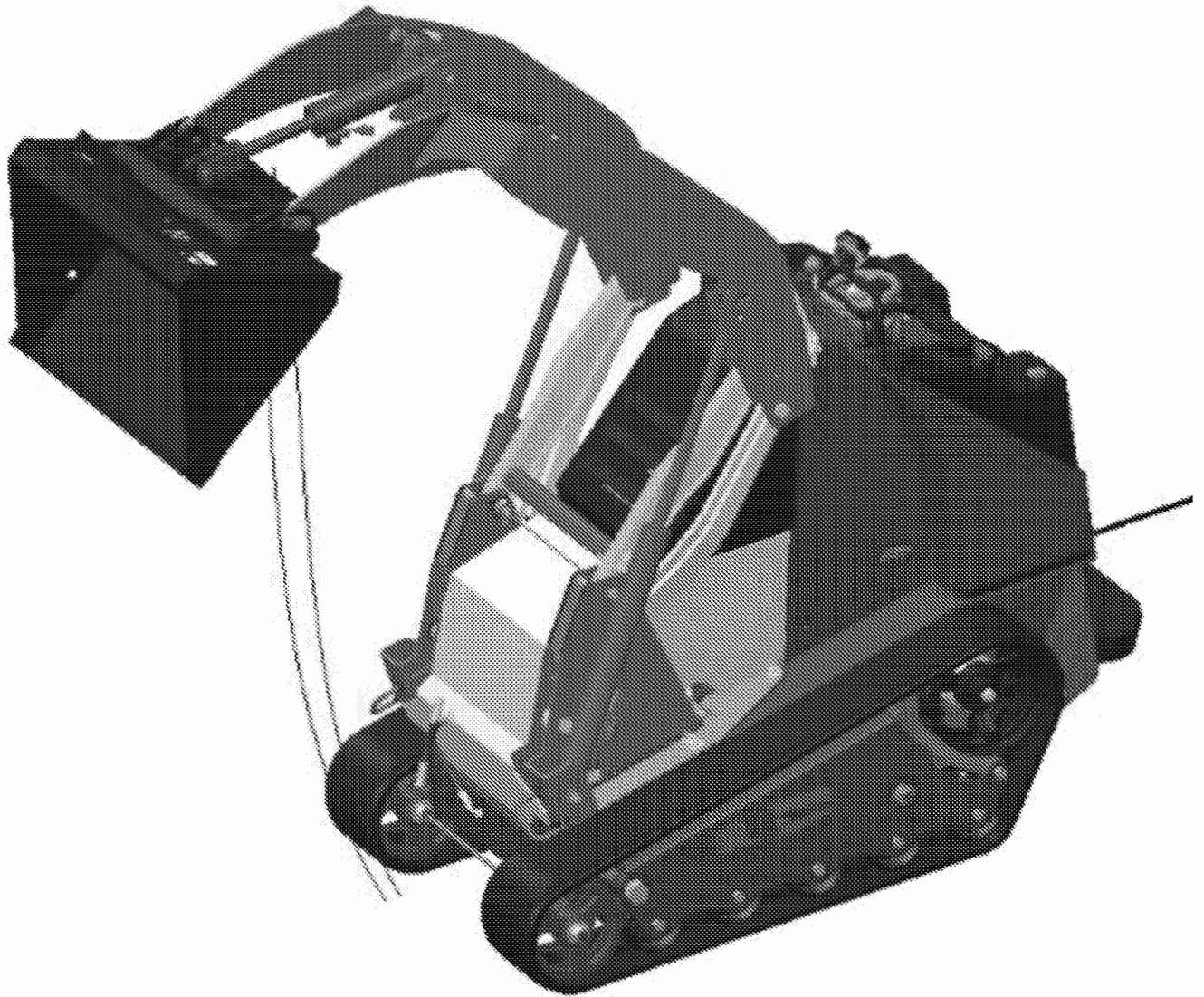


12/21/2015 9:37:05 AM 4

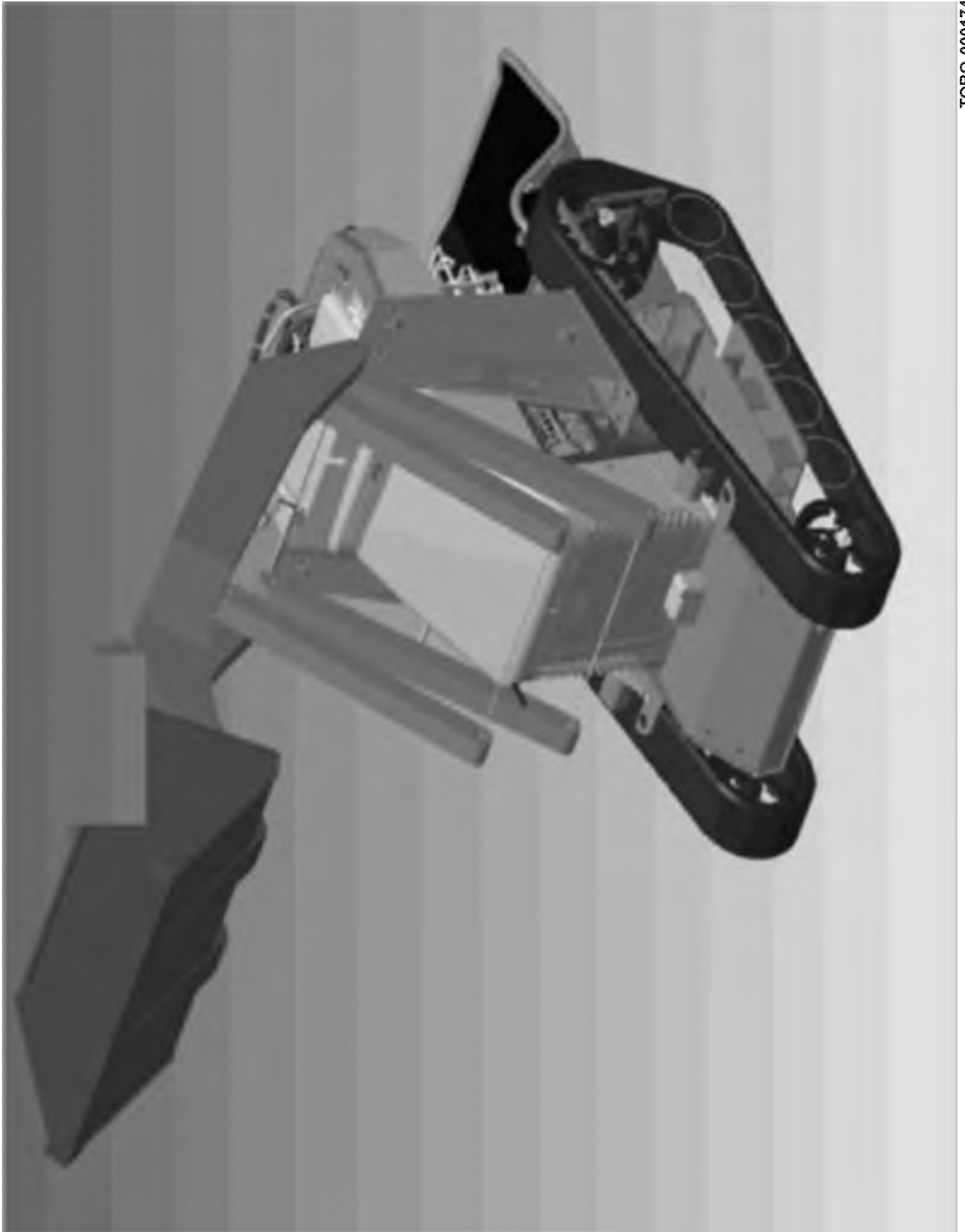
TORO-0001170.4/27



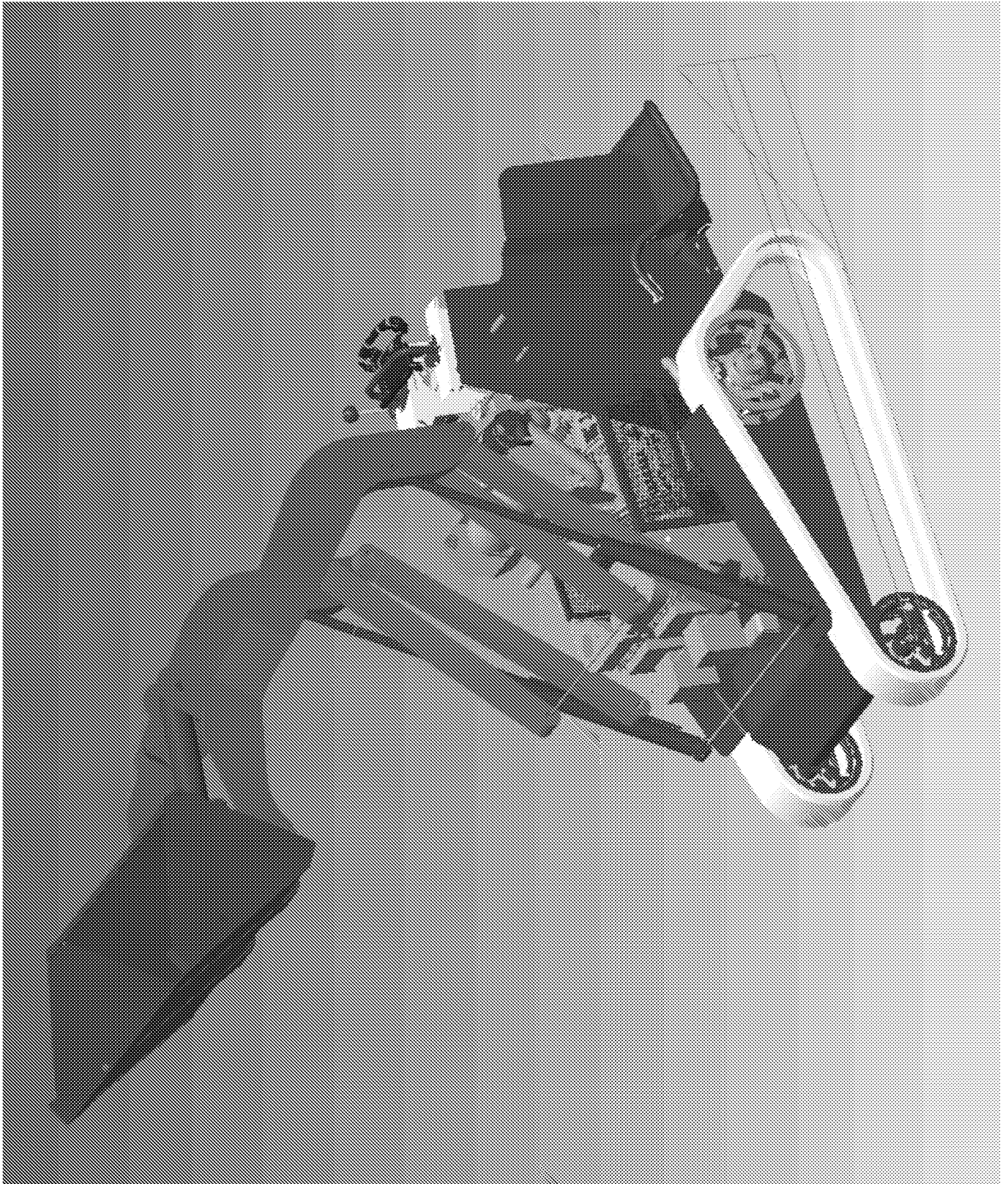
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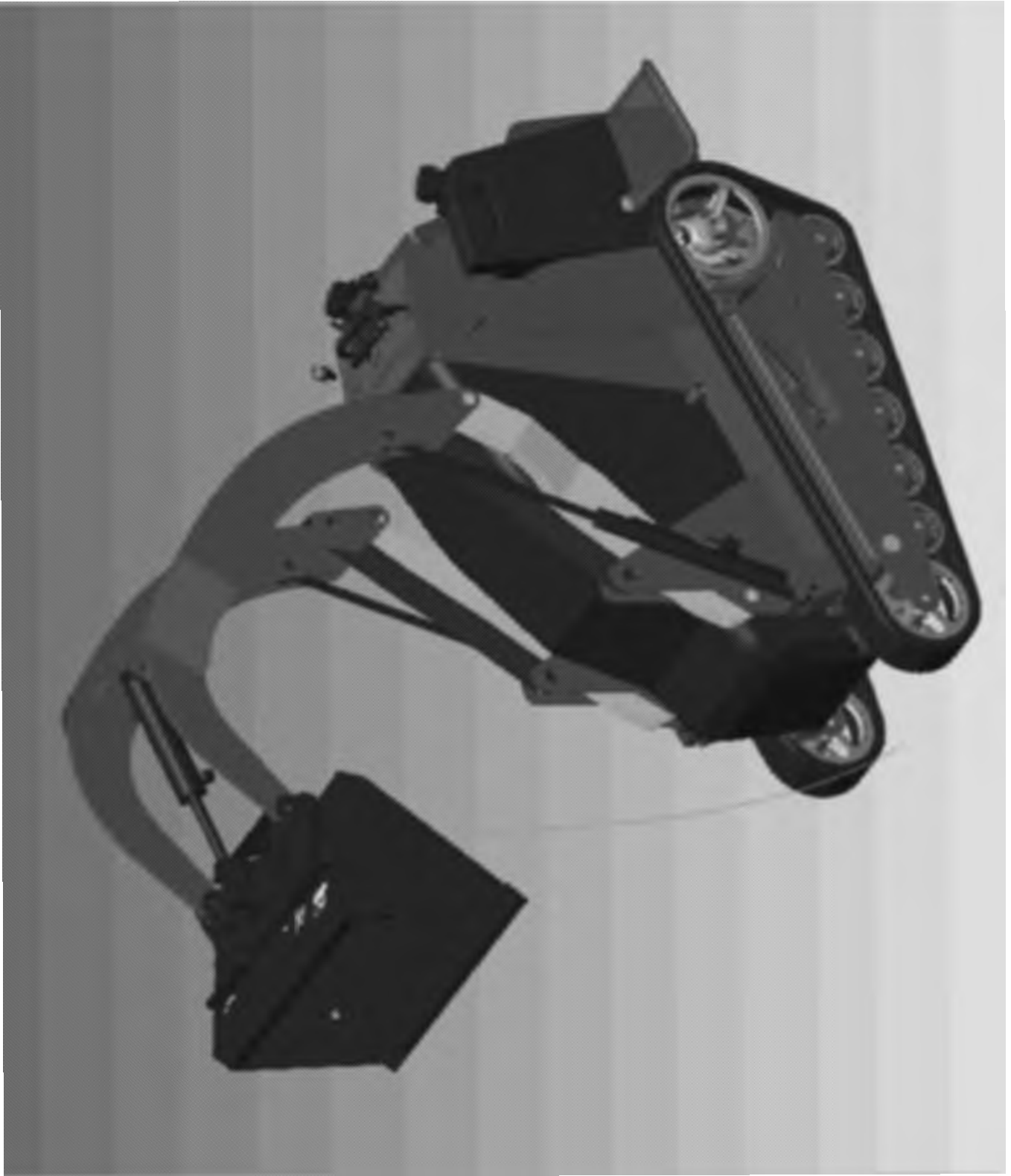
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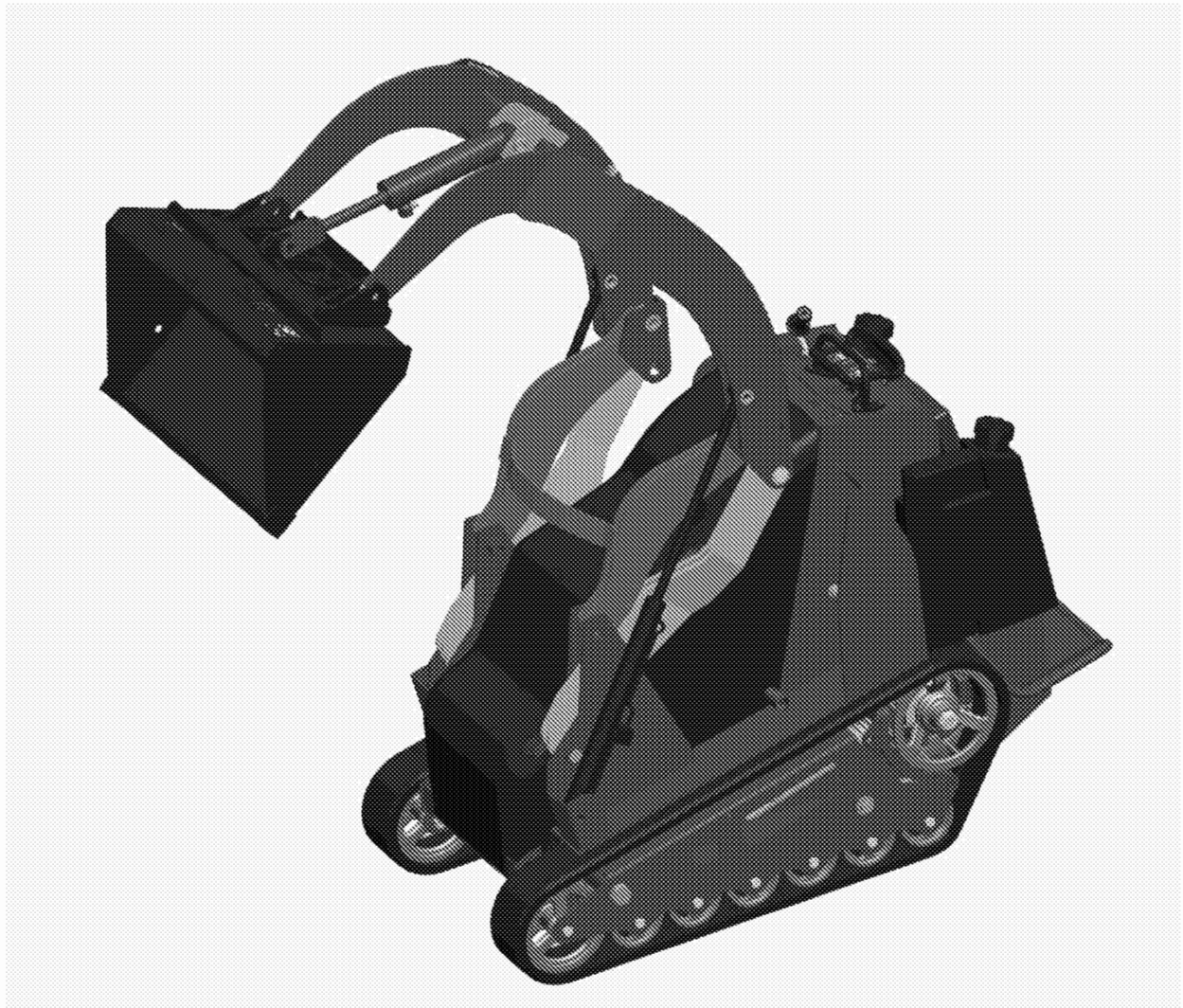
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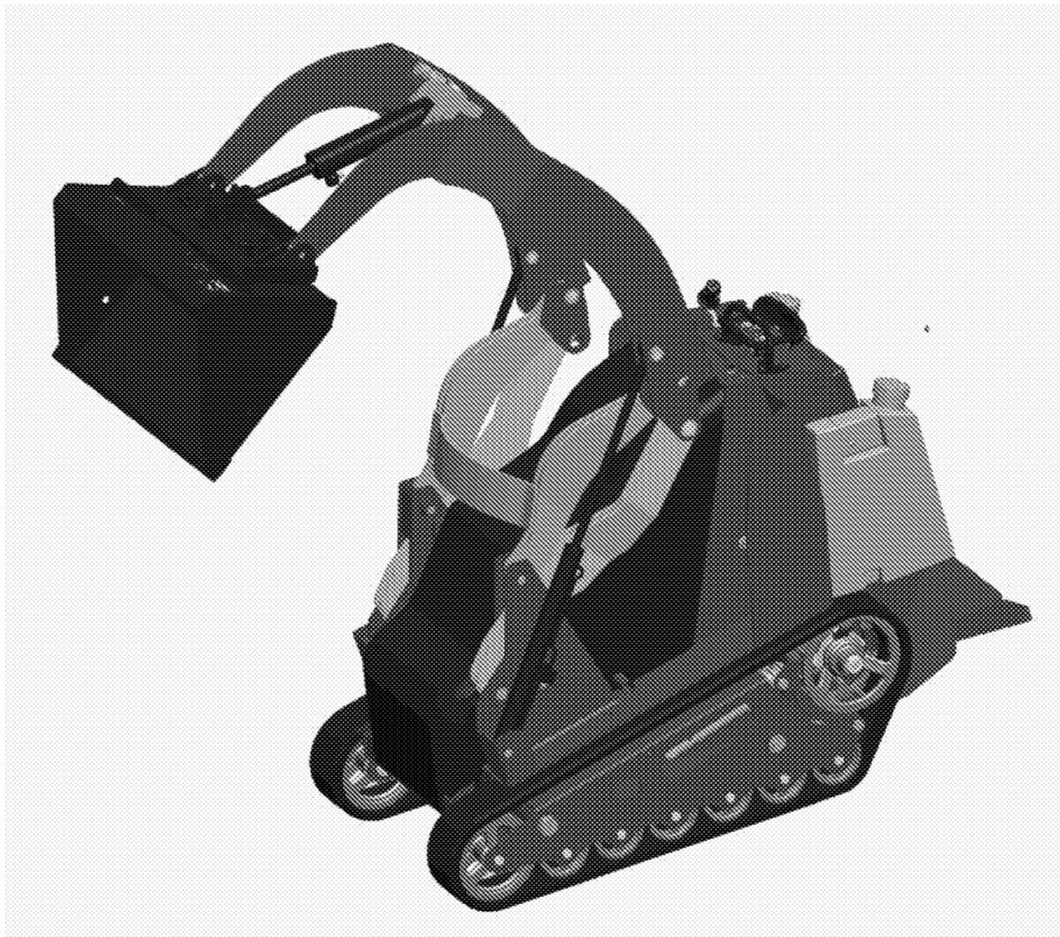
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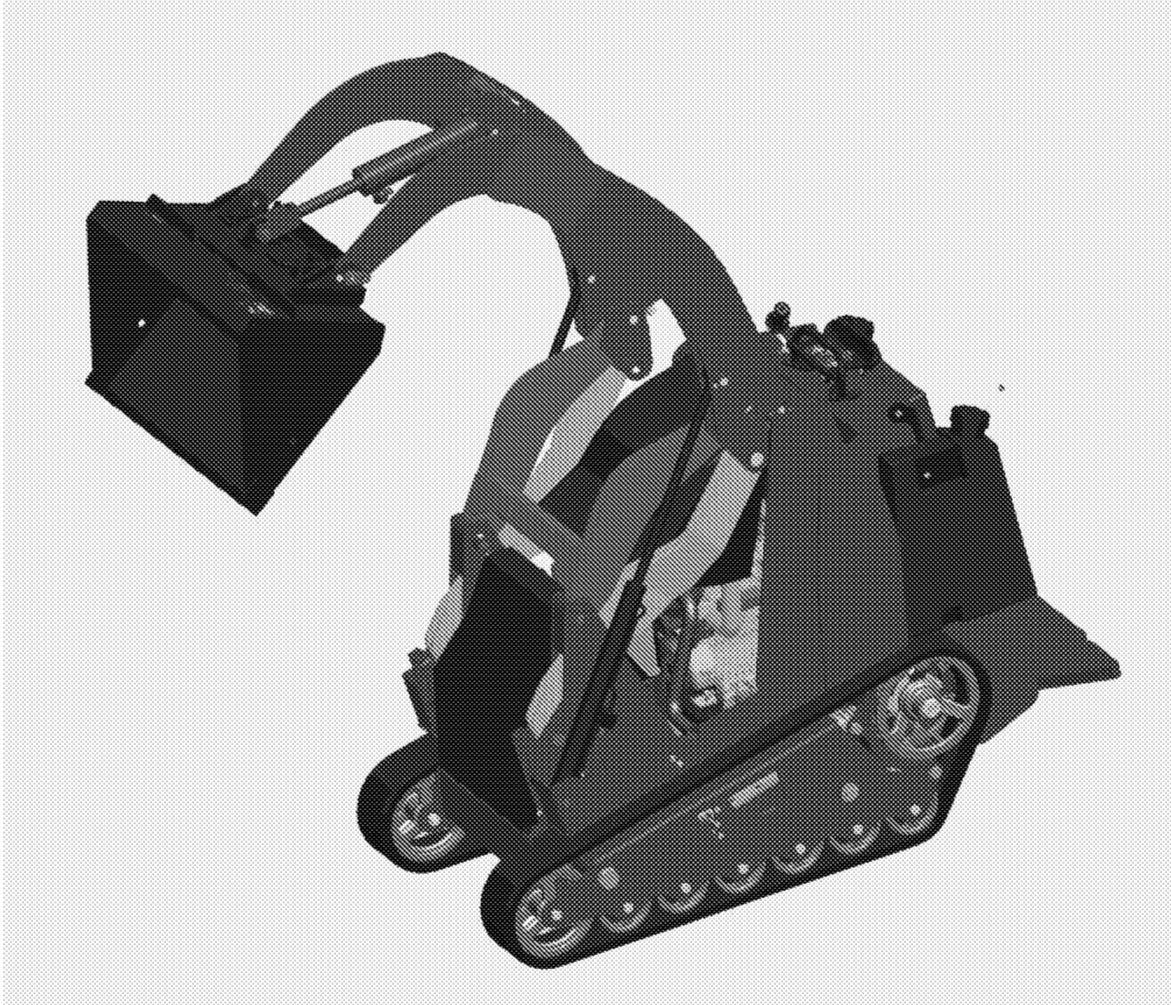
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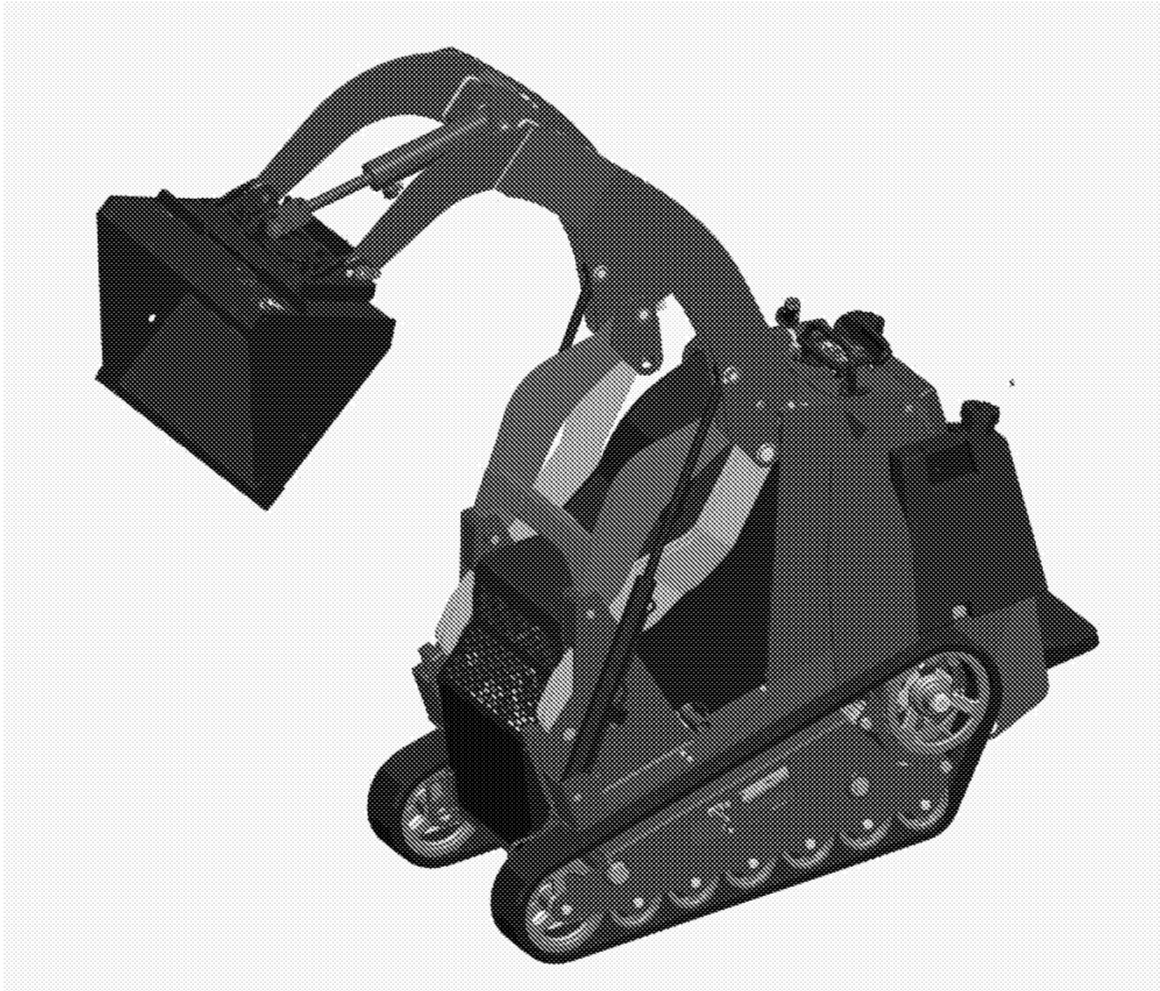
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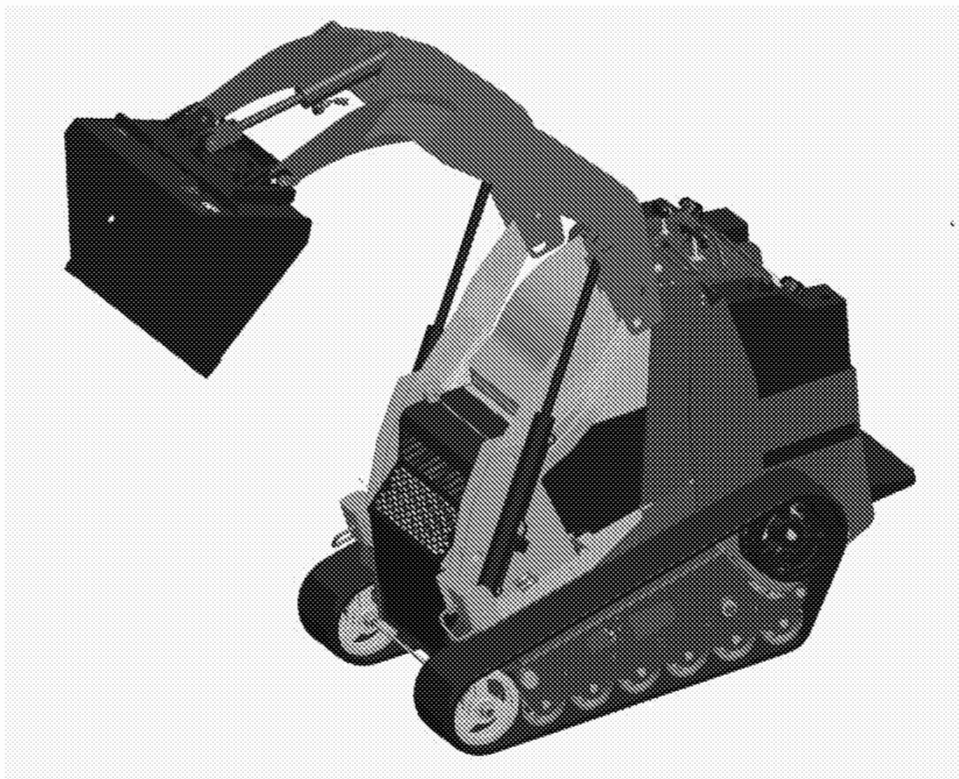
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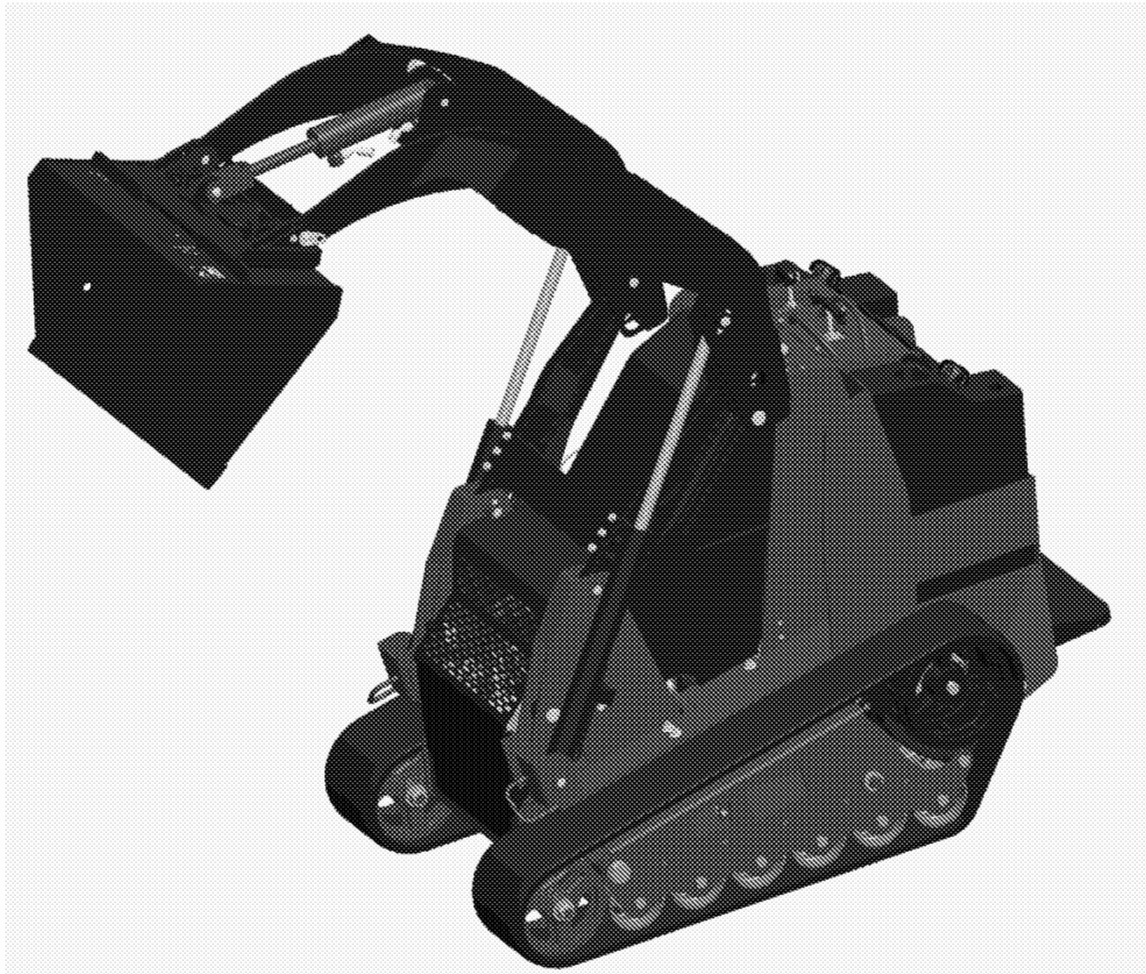
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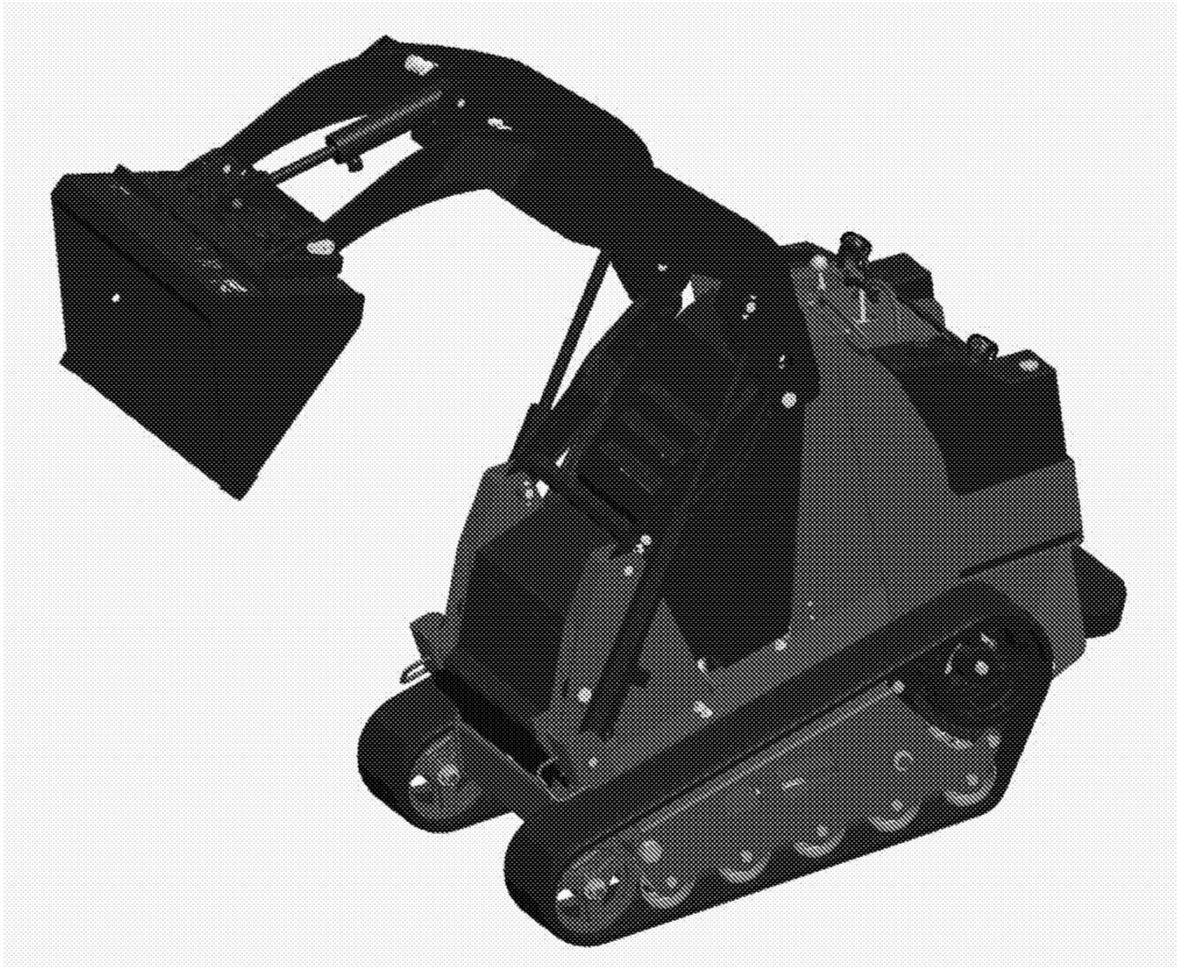
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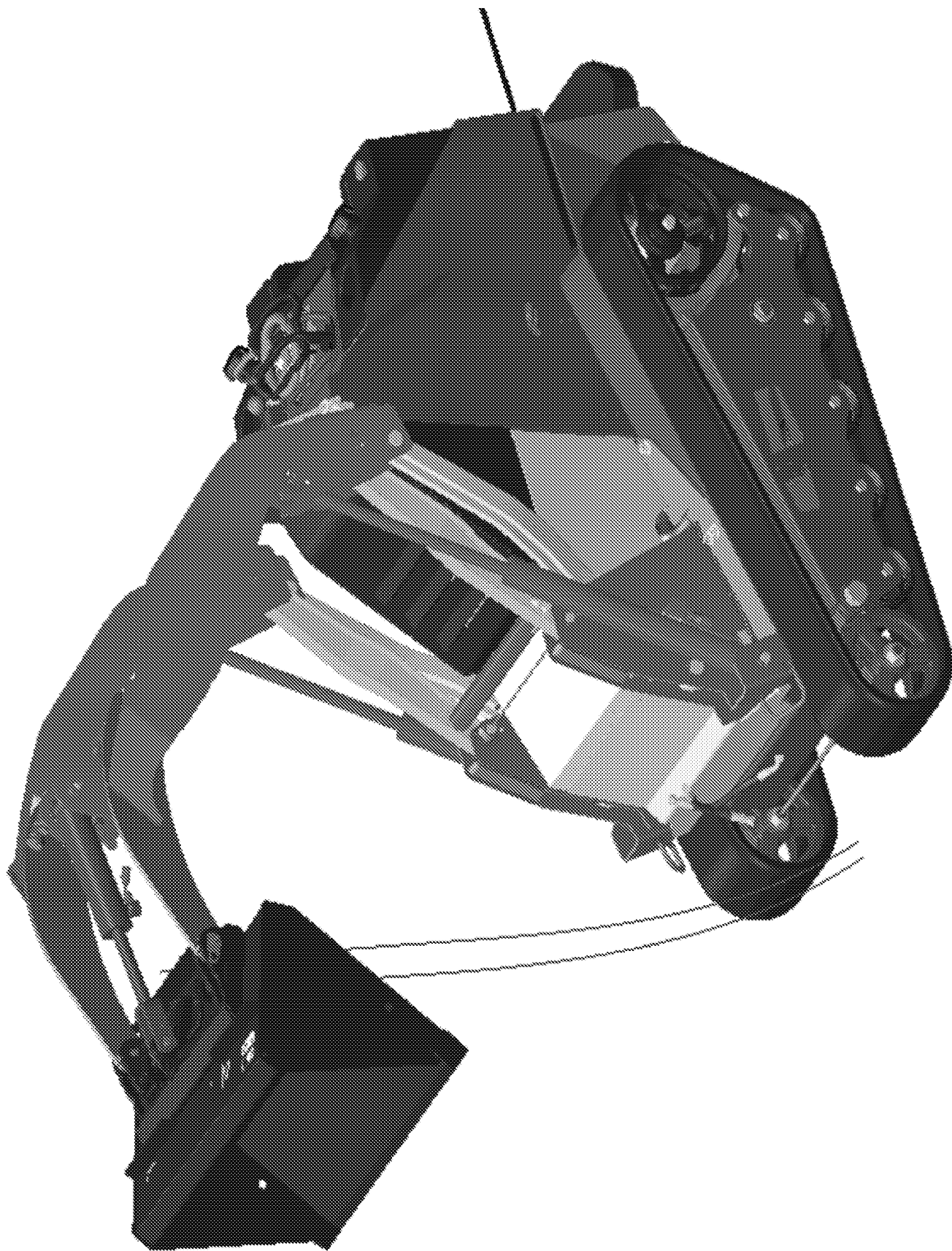
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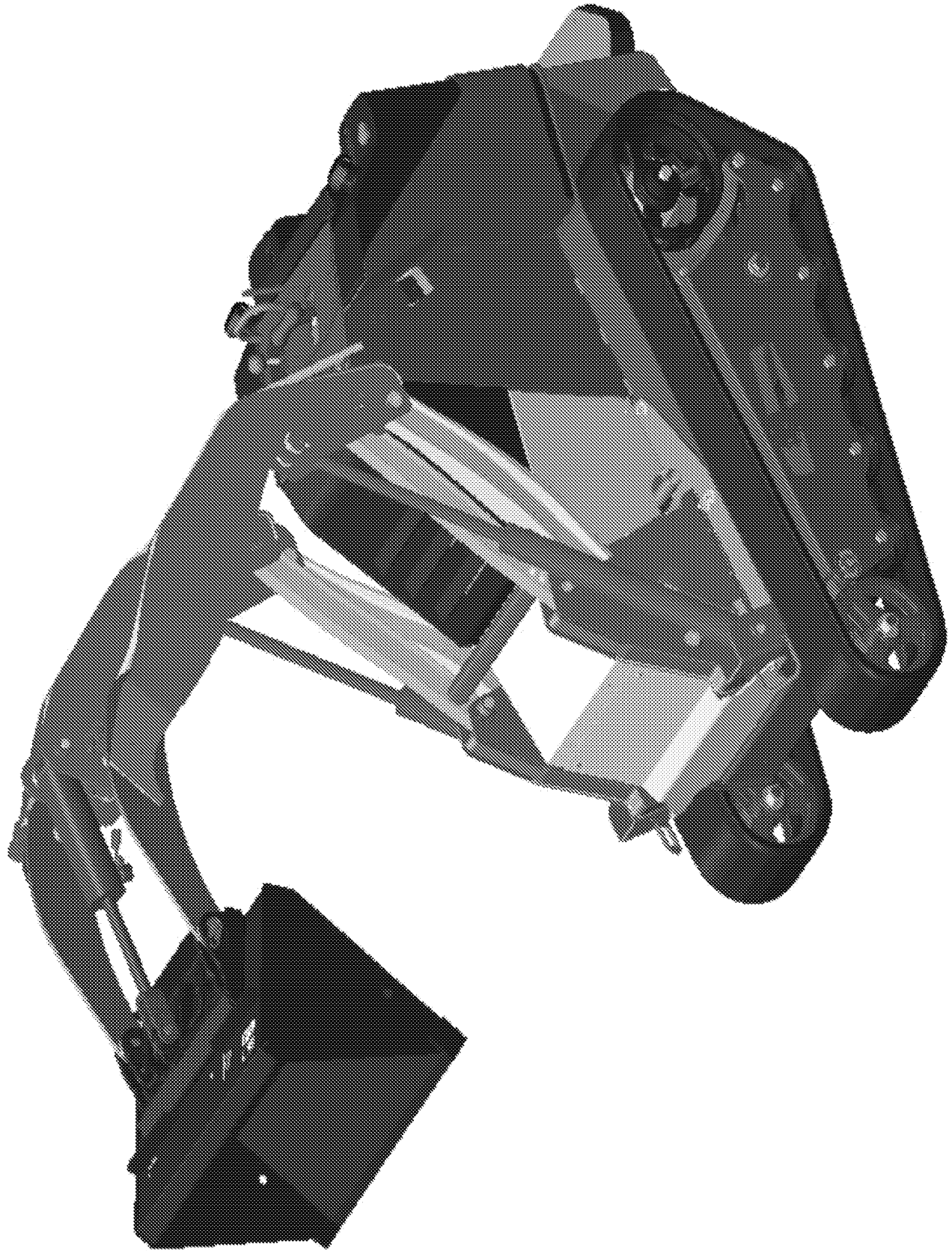
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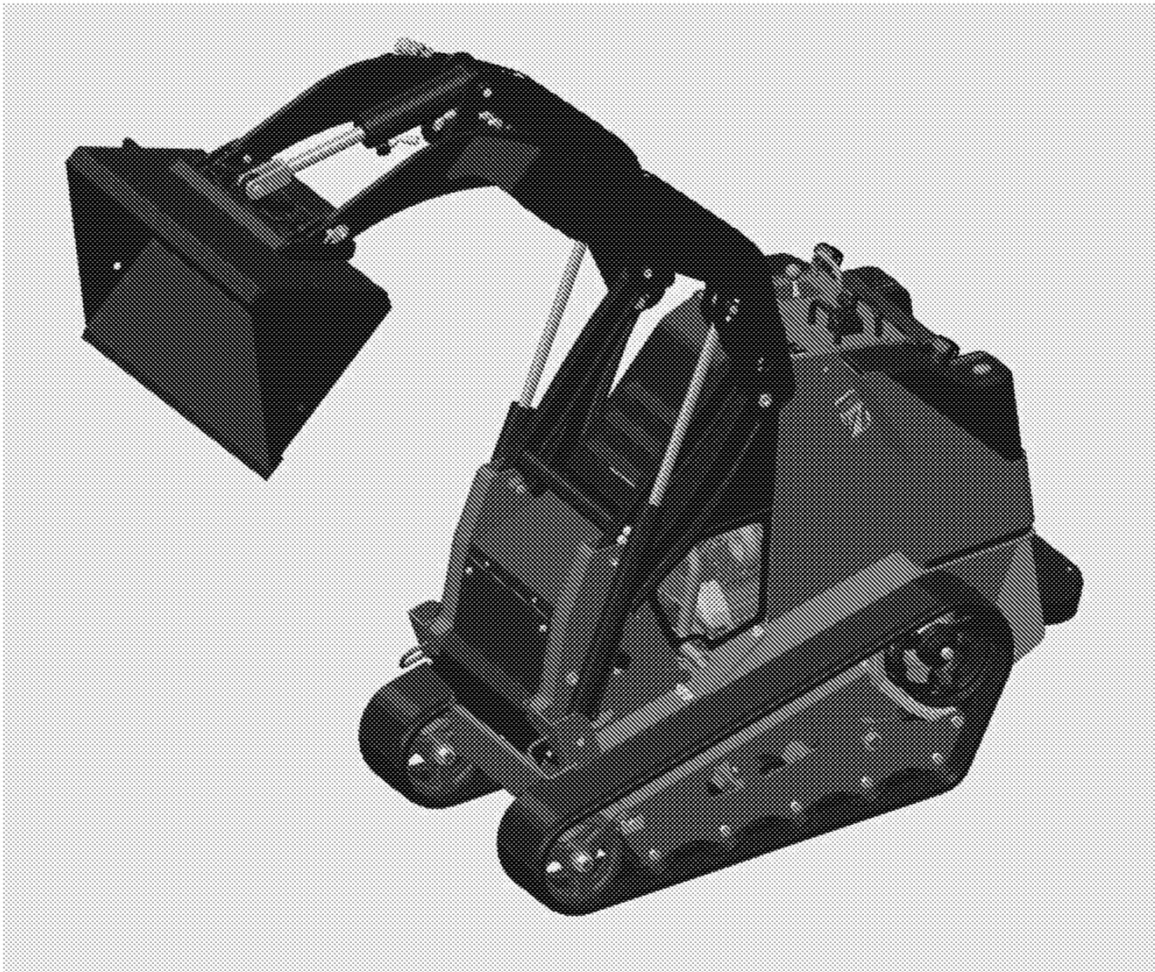
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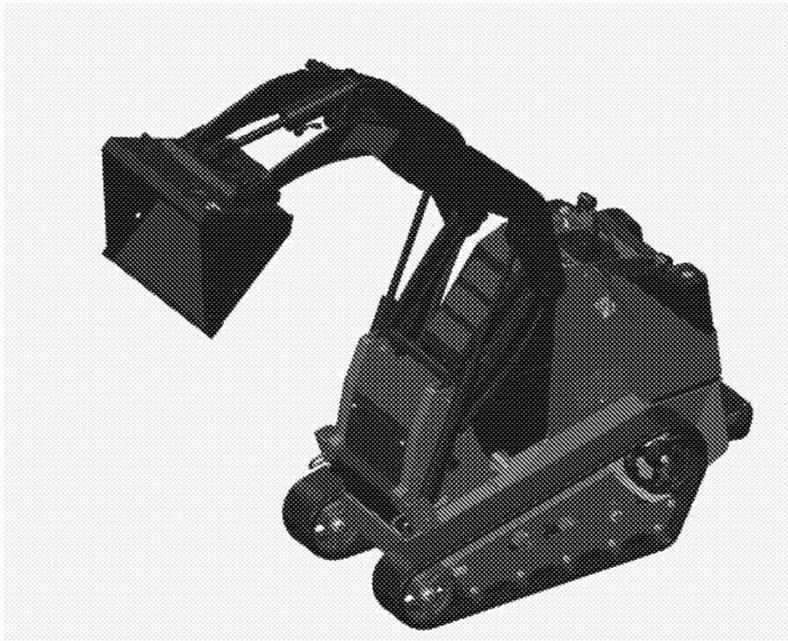
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TORO-0001758



TORO-0001759



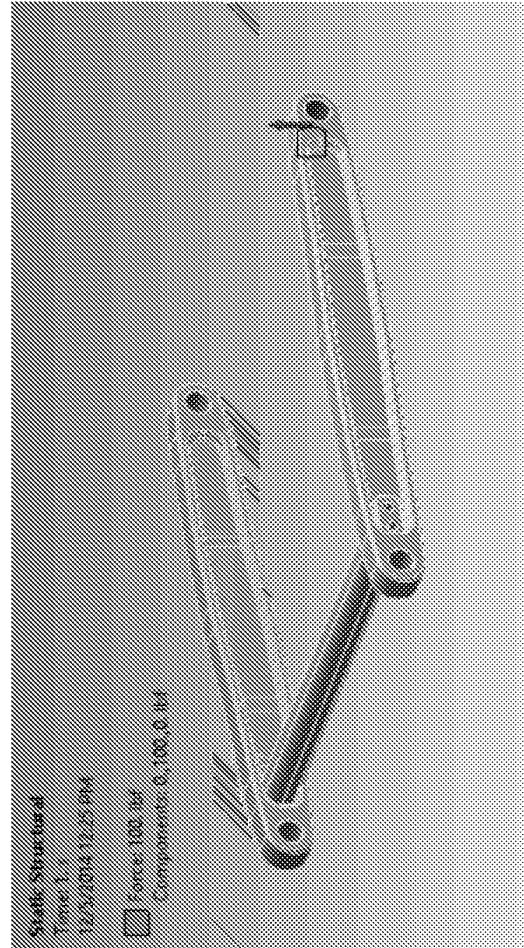
TORO-0001760



TX1000

Torque Tube

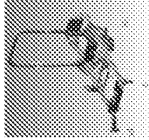
12/08/2014



TORO-0001918.1/10



Model



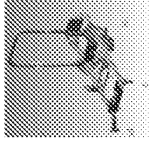
- Used geometry from upper_links_fea.asm.1
 - Last geometry, 4.0 Rev 2, will be updated

WINDCHILL/SWS/W298/UPPER_LINKS_FEA.ASM

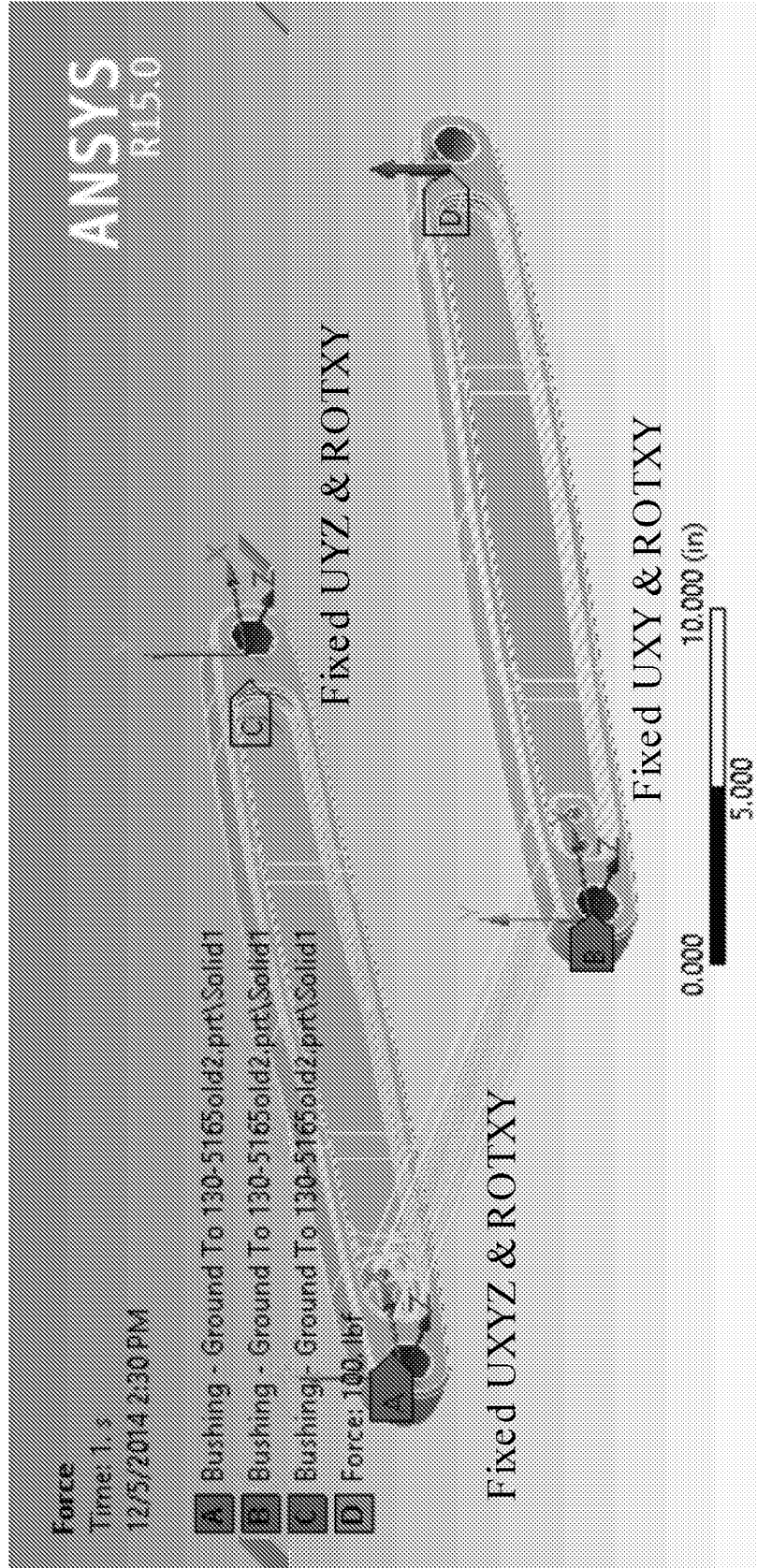
3.0	2	130-5165OLD2	LINK-UPPER
	1	130-5192	SUPPORT-CROSS OVER (MACHI
2.0	1	125-3710	LINKS/CROSSOVER.ASM (WELD
4.0	2	130-5165	LINK-UPPER (MACHI
	1	130-1132	SUPPORT-CROSSOVER, MACHIN
3.0 REV 2	2	130-5262	LOADER ARM LINK.ASM (WELD
	1	130-5269	CROSSOVER.ASM (WELDED)
4.0 REV 2	1	117-1874	UPPER LINK.ASM WELDED FUTURE

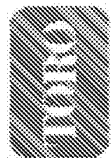


Torsional Loading



- 100 lb vertical force

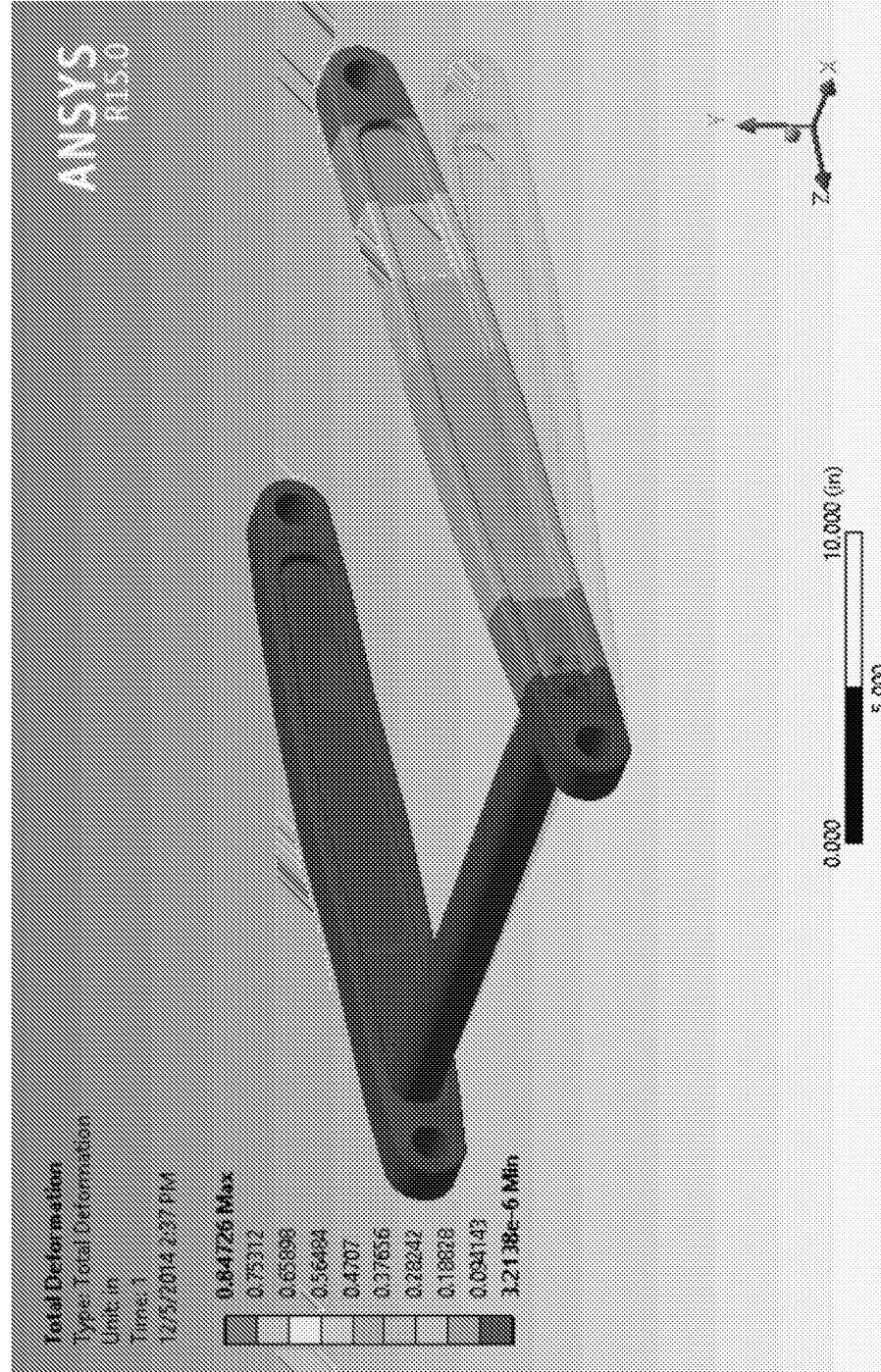




Configuration 3.0



- Deflection (in)

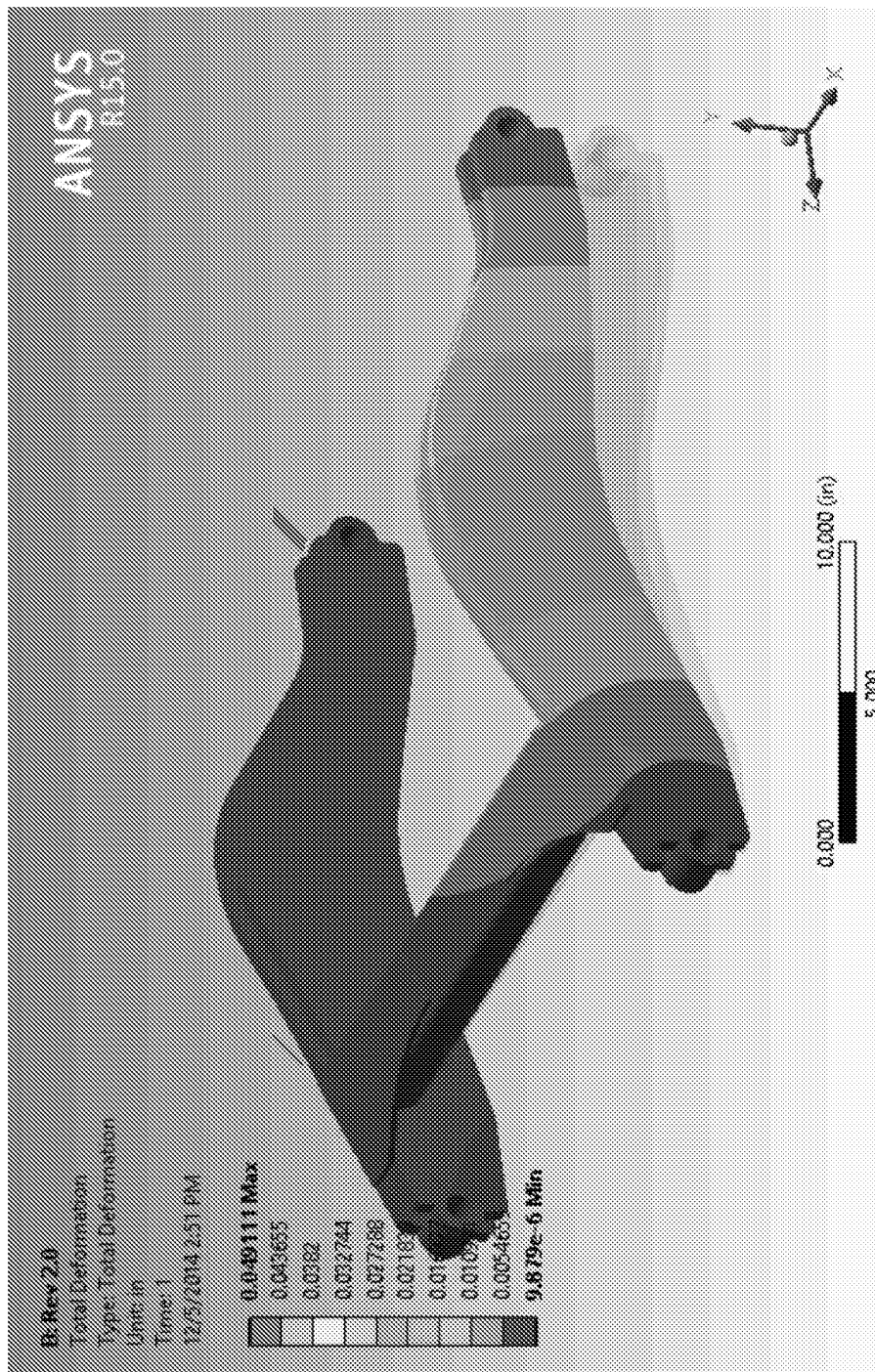




Configuration 2.0

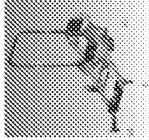


- Deflection (in)



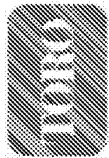


Configuration 4.0

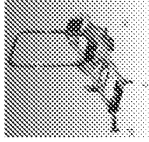


- Deflection (in)

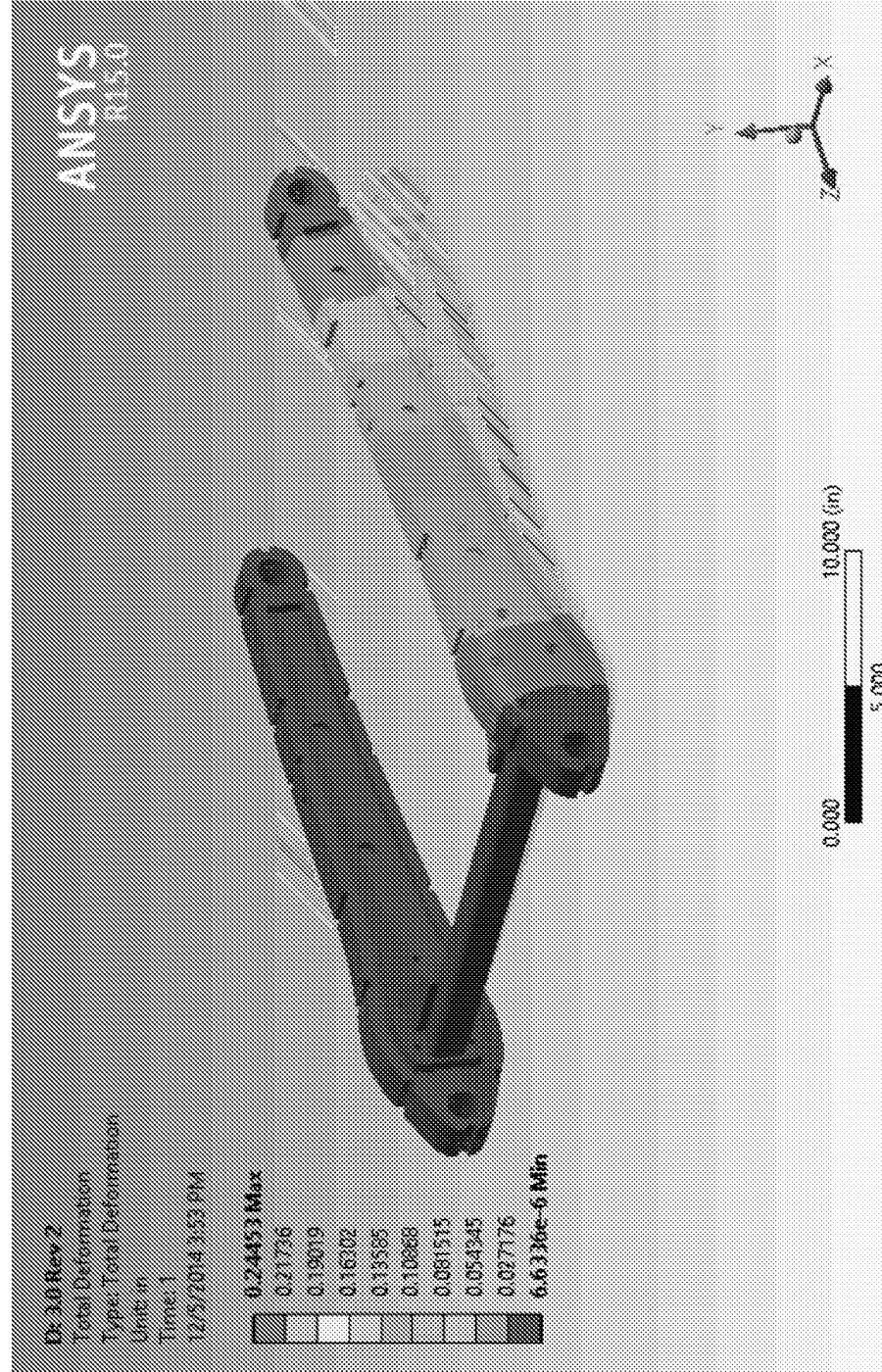




Configuration 3.0 Rev. 2



- Deflection (in)



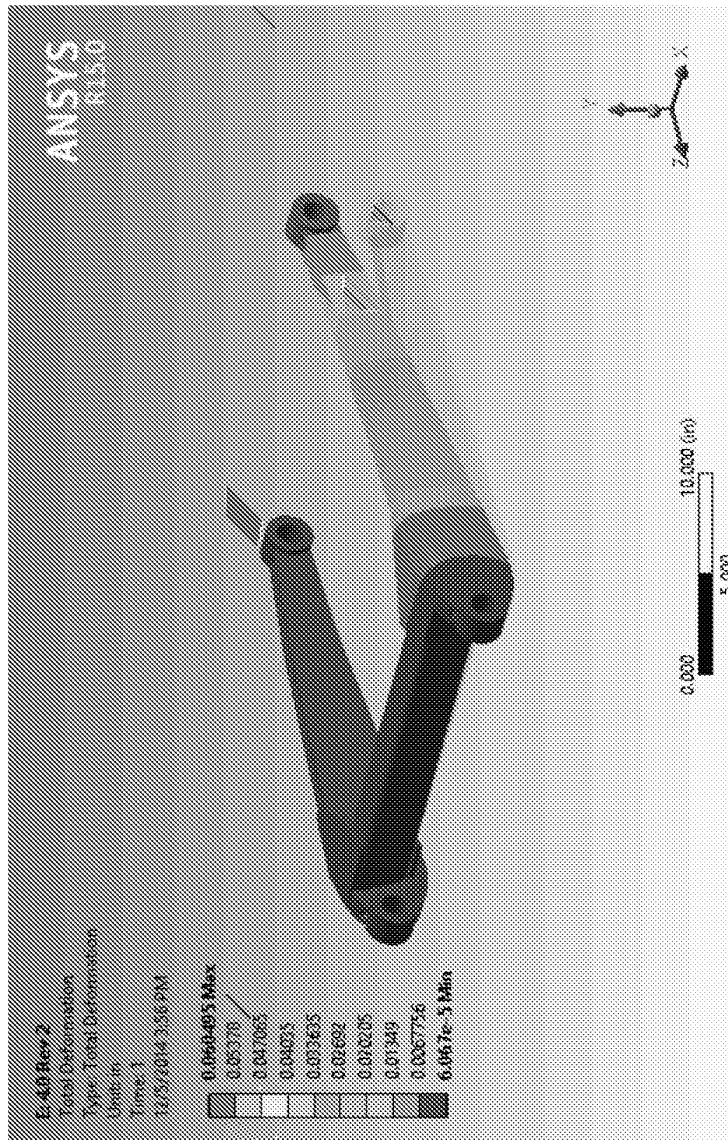


Configuration 4.0 Rev. 2



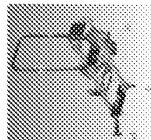
- Deflection (in)

A revision to this configuration is expected, after which thippt will be updated

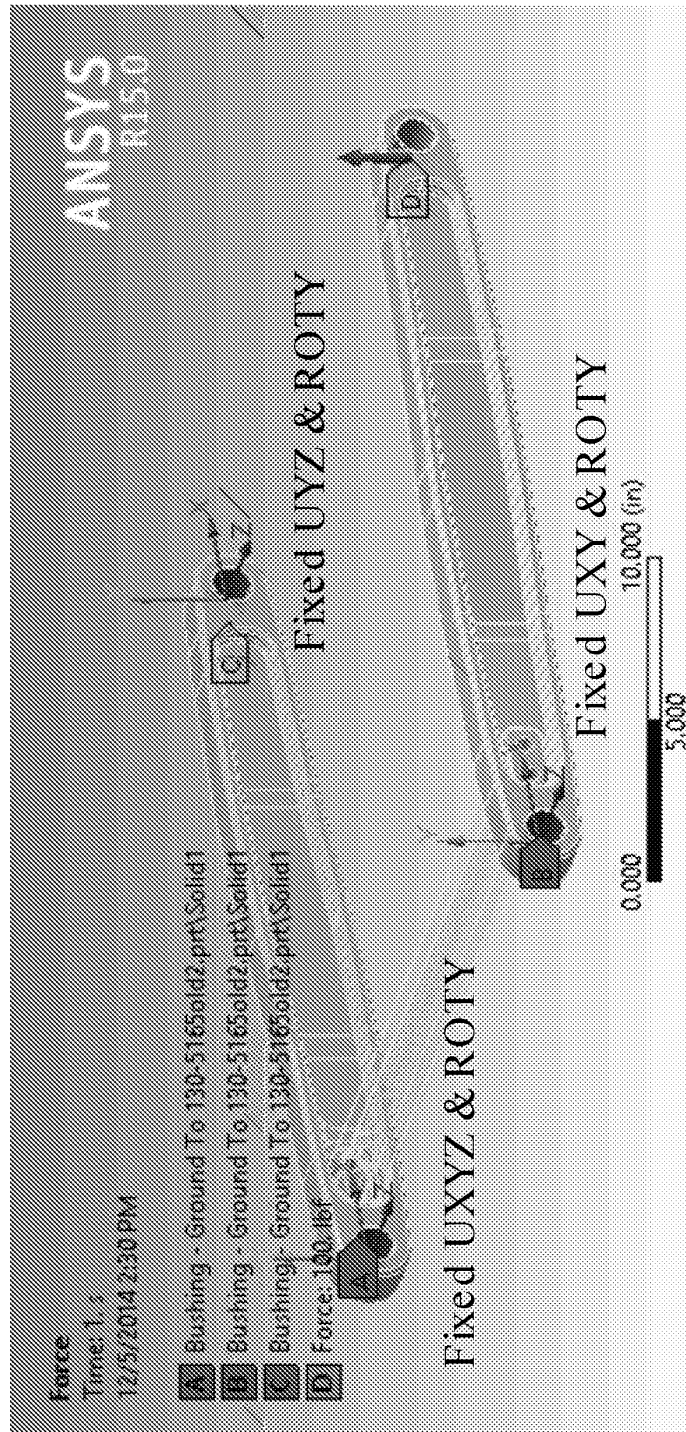




2nd Case, Torsional Loading

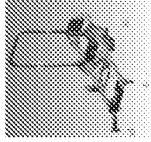


- Case with released ROTX (3 plcs.)
 - No pics included, but added to table of slide 10
 - 100 lb vertical force





Summary

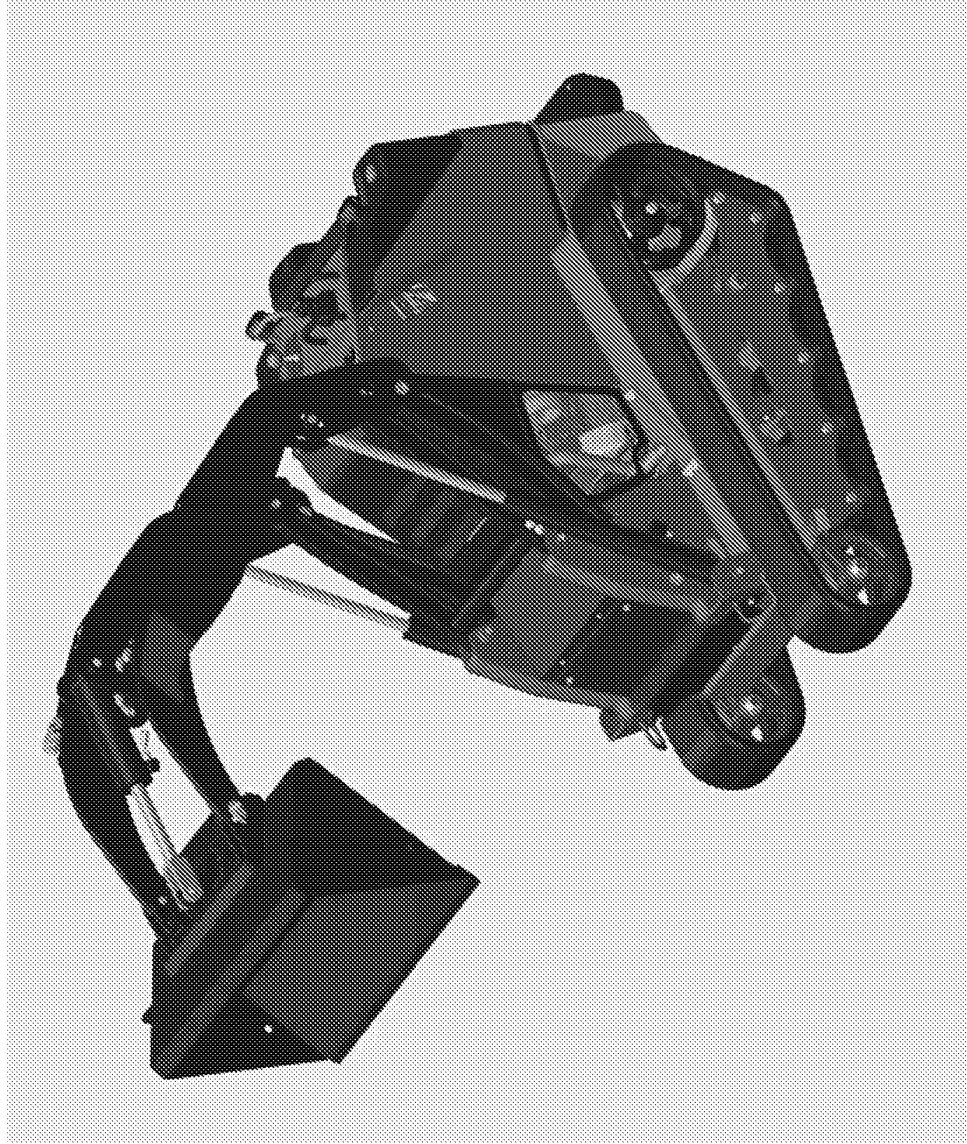


- Deflection (in)

Configuration	Case 1 Torsional Loading	Case 2 Torsional Loading (no ROTN)
3.0	0.847	1.355
2.0	0.049	0.051
4.0	0.077	0.089
3.0 Rev 2	0.245	0.248
4.0 Rev 2*	0.060	0.062

*Revision to this design/results expected

W298 TMAX UPDATE



REDACTED

2

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0003017.2/23

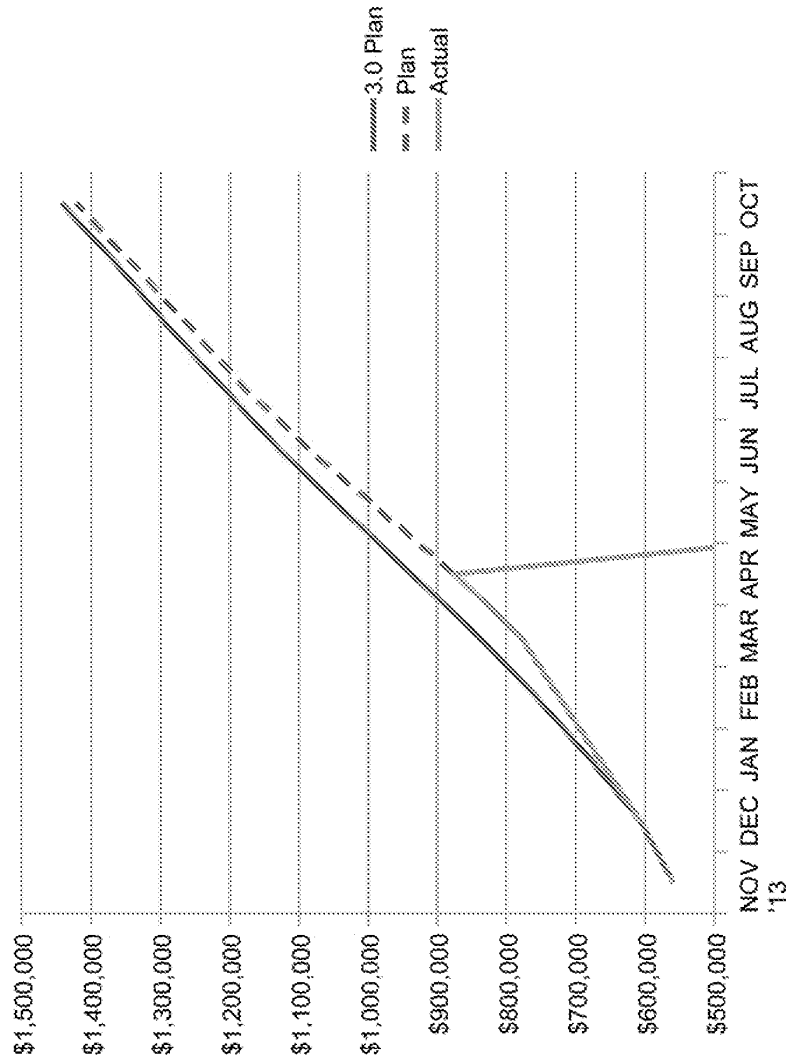
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CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0003017.3/23

W298 TMAX UPDATE

Budget Update

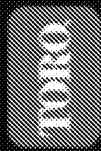


- Spending is favorable YTD but will catch up as parts P.O.s ramp up
- Graph assumes using \$10K from Holdback for Universal Engr.

REDACTED

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0003017.5/23



Count on it.

W298 TMAX UPDATE

Cost Updates

- Cost increases are mainly due to adding money back in to the loader arm and cylinders for durability after FEA results
- Cost decrease on the WT is mainly due to the drive wheel and track quote
- Still pursuing a major cost reduction on the WT bearing [REDACTED]
- Cost risks:
 - Final control configuration will likely add cost back
 - Main loader castings, not all final quotes are in
 - Assembly and weld rates have not been reviewed since 3.0

REDACTED

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0003017.7/23

REDACTED

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0003017.8/23



Count on it.

W298 TMAX UPDATE

Test Updates – 2.0 machines

- Both machines were updated with heavier duty arms and lift cylinders (still 2.0 geometry)
- Duty cycle work with several attachments was completed at Riverside to verify FEA numbers and scaling

- Trenching
- Auger
- Bucket
- Leveler
- Forks
- Grapple





Count on it.

W298 TMAX UPDATE

Schedule Update

Milestone Dates	3.0 Plan	Update	Comments
3.0 Signoff	2/17/14	2/17/14	
3.0 Prototype Build Completed	5/27/14	6/19/14	Current date assuming tooled radiator lines and tanks
3.5 Update	6/23/14	7/28/14	Control decision after VOC of 3-4 designs
Long Lead / Tooling Releases	9/25/14	10/6/14	Assumes 16 wk lead time – Poclain pumps will be earlier
4.0 Signoff	10/15/14	11/7/14	
4.0 Updates	10/29/14	11/10/14	Complete 500 initial test hours and then update – Completely update Mktg unit for Sales mats
5.0 Signoff	1/5/15	1/12/15	
Pilot Build Completed	1/14/15	1/23/15	
Rental Show 2015		2/22/15	See Marketing plan if pilots are not available for ARA
Production	3/12/15	3/23/15	
Release to Ship	3/19/15	3/30/15	

10

W298 TMAX UPDATE

Schedule Issues – Getting back on track

Long lead items

- Radiator hoses could not be finalized until the radiator was finalized; these need to be tooled and held us up during the 2.0 build
 - Action Plan: Push Veyance to make hoses; temporarily use flex hoses
- Fuel tanks require long lead tooling; We did not want to finalize the design until we were satisfied with the shape and function
 - Action Plan: Run with temporary tanks until tooled tanks are available
- Loader castings — see next page

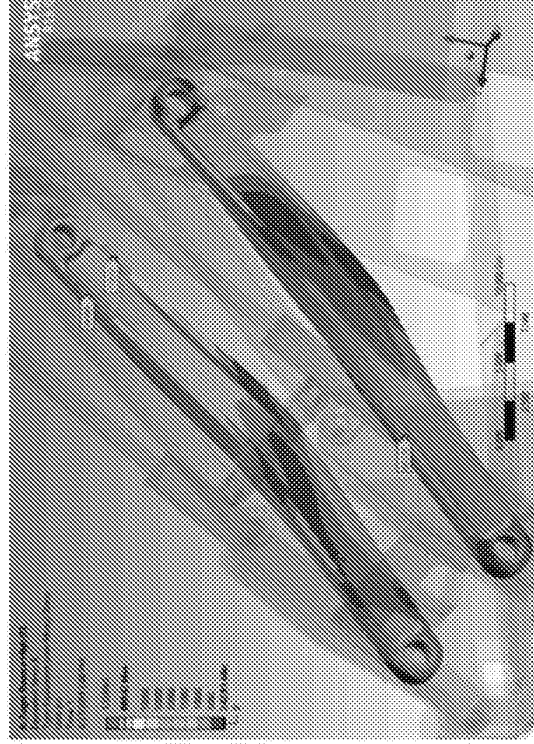
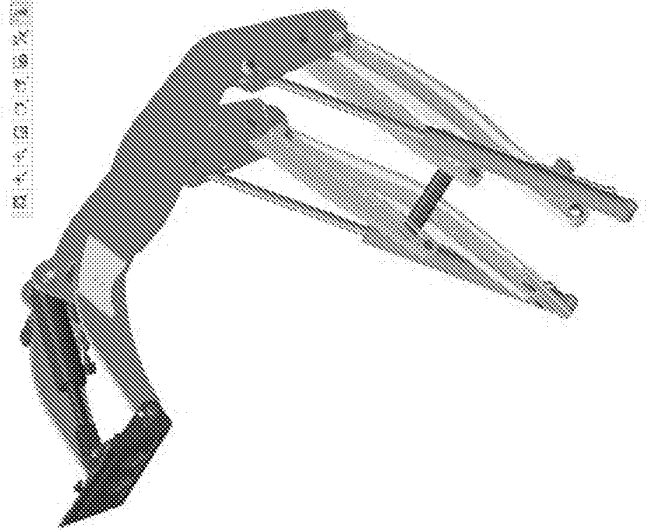
W298 TMAX UPDATE

Schedule Issues – Getting back on track

Ensuring durability

- Since the loader is a major durability concern, those parts were held until a 2nd iteration of FEA was completed and verified against field data

– Action Plan: Castings have been upgraded based on FEA and sourced with Craft and are not going to be an availability issue



W298 TMAX UPDATE

Controls

- Based on VOC, team has been challenged to come up with controls that are better suited for the Next Gen (controls that closely align with this larger, faster machine with dedicated platform)
- On Next Gen units the current TX-style controls are:
 - not ideal for operating with one hand – max efficiency requires controls be operated with one hand majority of the time
 - too big and bulky for the larger, higher speed machines on the market today
 - too cumbersome and time consuming when performing the significant number of tight turns that are required at today's jobsites, especially with higher speeds
 - best suited for walk behind units



Count on it.

W298 TMAX UPDATE

Schedule Issues – Getting back on track

Controls

- Implementing control ideas that work – We are still searching for an acceptable method of actuation and control shape
 - Action Plan:
 - Build with “default” two-lever design; the control area is designed so it can be easily switched out on the prototypes
 - Assign one design idea to Joe Knipp to finish out (Dogbone)
 - Utilize Universal Engineering for a 2nd design (Steering Wheel)
 - Complete VOC in June and July with a decision by the end of July
 - Assuming 14 weeks of testing prior to 4.0 update, controls will still have 350 hours on them before 4.0
 - Lab cycle testing of agreed-upon control system

REDACTED

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0003017.15/23

REDACTED

TORO-0003017.16/23

CONFIDENTIAL - ATTORNEYS' EYES ONLY

REDACTED

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0003017.17/23

REDACTED

TORO-0003017.18/23

CONFIDENTIAL - ATTORNEYS' EYES ONLY

REDACTED

TORO-0003017.19/23

CONFIDENTIAL - ATTORNEYS' EYES ONLY



Count on it.

W298 TMAX UPDATE

Ditch Witch VOC

- Consistently positive feedback on the controls
- High value placed on the platform and foot pedal
- Combination of increased specs and price is attractive to landscapers
- Track system does have its deficiencies



W298 TMAX UPDATE

Recent Competitive Actions

- How have competitors responded to Tier 4 Final?
 - Vermeer S800 TX now features a 40hp EFI engine (formerly a 35 hp diesel)
 - Reportedly, Ditch Witch is no longer manufacturing the SK 755 (featured 32.8 hp diesel engine), just the SK 750
 - The Ditch Witch SK 750 has the same lift capacity and lift height as the 755 but features a 24.8 diesel engine

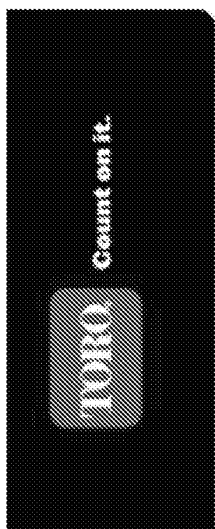


Count on it.

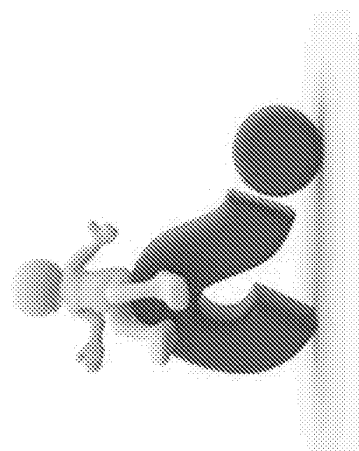
W298 TMAX UPDATE

Launch Planning

- Conducting regularly scheduled launch planning meetings
- Met with AV regarding timing of introduction, photography and video needs
- Held initial discussion with Performance Marketing regarding launch timing, launch communication ideas, and advertising plan
- June 5 meeting scheduled to discuss 2015 trade show assets and planning
- Launch will also focus on the entire family of Dingo products
 - No comparable breadth of product in the marketplace
 - All video, literature, and images of current TX and Wheeled Dingo product and attachments will also be updated
 - Updating of materials for current product will be done this summer (July 22-24)



Questions?

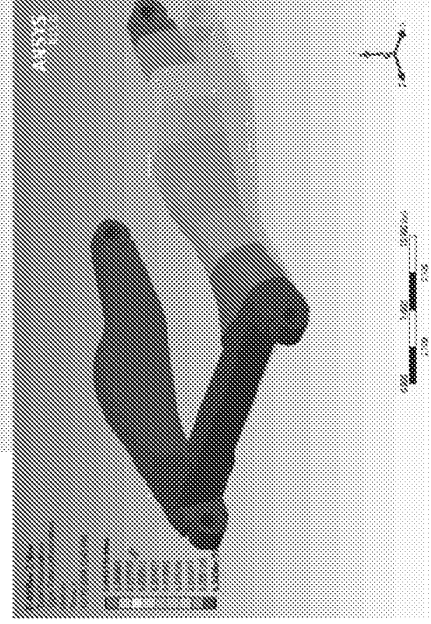
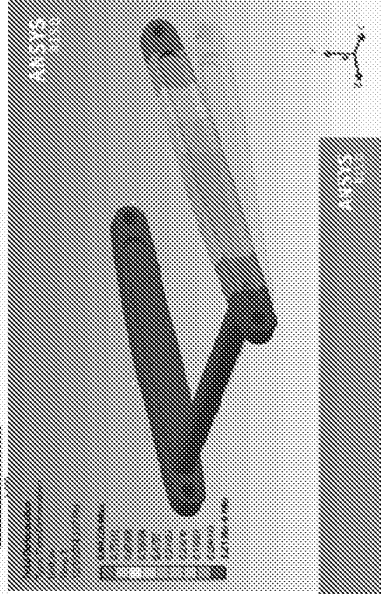
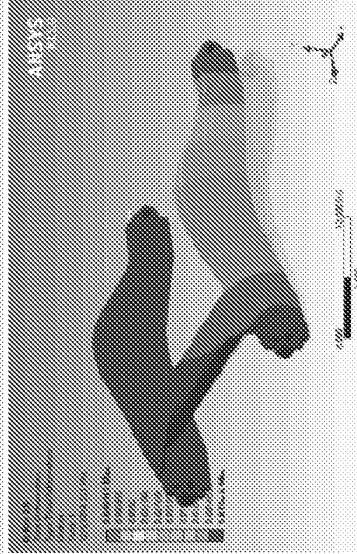


W298 TX1000 UPDATE

12/15/14

Loader Arm Testing

- FEA has confirmed the upper link can flex to cause independent movement between the lift cylinders
- A fabricated single piece link was designed to exceed the 2.0 design (since this design does not have a racking problem)
- Proceeding with updating all machines with this design
- FEA on entire loader will be re-run with the new piece to confirm





Count on it.

W298 TX1000 UPDATE

12/15/14

Loader Arm Testing

Configuration	Case 1 Torsional Loading	Case 2 Torsional Loading (no ROIN)
3.0	0.847	1.355
2.0	0.049	0.051
4.0	0.077	0.089
3.0 Rev 2	0.245	0.248
4.0 Rev 2	0.046	0.048



W298 TX1000 UPDATE

12/15/14

Combined Flow Aux. system

- The lab unit was set up with a combined flow system and run with the auger (found to be acceptable)
- Gear pumps are in to update all 4.0 machines with combined flow pumps
- This also gives us a future “low flow” option feature if we want it by adding a diverter valve to the circuit
- Will still pursue a split flow system as backup, but combined is the “default” design at this point.



W298 TX1000 UPDATE

12/15/14

Engine Heat work

- After modifications to the rear radiator intake; heat runs were able to be completed
 - Water and oil cooling seems adequate but we are not expelling the heat from the machine
 - Need to find exit lanes for the air out the front of the machine (move air cleaner, open up hood louvres)



W298 TX1000 UPDATE

12/15/14

Controls

- Input received from Micron on shaping, fastening, and materials for control parts
 - Outer handle: glass infused nylon
 - Inner ball: delrin
- Longer handle printed to increase available rotation (on the field unit)



REDACTED



Count on it.

W298 TX1000 UPDATE

12/15/14

Tomah Build / Releases

W298 Tmax	1305 Refit Plan	Current / Actual	Notes
Weld tool releases (902)	n/a		
Other long lead releases (902)	n/a		
3.0 updates (rework frame, muffler, and hoses)	11/12/2014	11/20/2014	1st unit up and running; 2nd unit followed a few days later
500 hours completed (902)	n/a	n/a	The D902 3.0 machine stopped at 224hrs due mainly to poor weather
Weld tool releases (1305)	11/5/2014	11/24/2015	Loader arm was the last major weldment released; still a full 16 wks from pilot date; a few minor weldments (platform) are still unreleased as we design around them
Other long lead releases (1305)	12/5/2014	12/1/2014	Engine was released 12/1. Combined flow pump is not released but is already in Casappa's system and readily available
4.0 updates / 1305 refit	1/15/2015	1/16/2015	Current start date for the build is 1/12
Final releases	1/27/2015	1/27/2015	
Pilot Build	3/10/2015	3/16/2015	Date officially in the line 15 schedule
Production	4/28/2015	4/22/2015	Date officially in the line 15 schedule
Release to ship	5/5/2015	5/5/2015	
500 hours completed 1305	6/9/2015	6/9/2015	
1000 hours on engine	10/27/2015	10/27/2015	



W298 TX1000 UPDATE

12/15/14

Tomah Build / Releases

- 4.0 build
 - Releasing the last of the steel parts for the 4.0
 - Will begin some teardown work on the 3.0's this week (loader test unit, field unit?)
 - Most weldment parts are due in prior to Christmas, will depend on Woody's availability
 - Will need to tool handle parts from a rapid prototype vendor
 - Gabe will likely weld all of the new upper links for 4.0 updates
- Production
 - Stock Kubota engines will need to continue to be used until we finish Kubota's application approval, possibly up to and including first production
 - Stock engines already ordered for pilot
 - Will possibly route through a Kubota dealer to rework to our spec

REDACTED

TORO-0003170

CONFIDENTIAL - ATTORNEYS' EYES ONLY



Count on it.

W298 TX1000 UPDATE

12/15/14

Photo/video shoot - Pensacola, FL

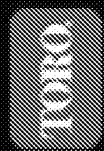


9

TORO-0003171

W298 TX1000 UPDATE

12/15/14



Count on it.

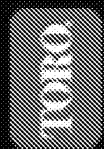


10

TORO-0003172

W298 TX1000 UPDATE

12/15/14



Count on it.

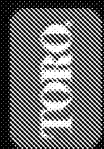


11

TORO-0003173

W298 TX1000 UPDATE

12/15/14



Count on it.



W298 TX1000 UPDATE

12/15/14

TORO
Count on it.



13

TORO-0003175



Compact and H.

W298 TX1000 UPDATE

12/15/14



TORO-0000563



Count on it.

W298 TX1000 UPDATE

12/15/14

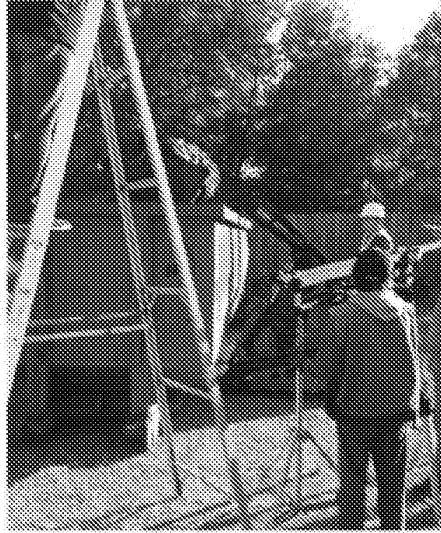


TORO-0000564



W298 TX1000 UPDATE

12/15/14



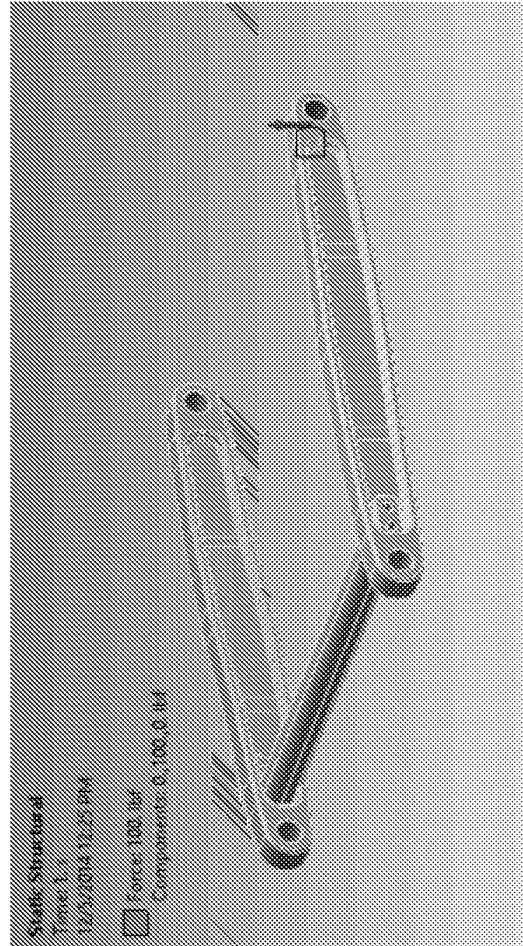
TORO-0000565



TX1000

Torque Tube

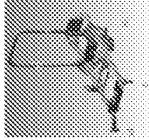
12/11/2014



TORO-0000571.1/10



Model



- Used geometry from upper_links_fea.asm.1
 - Last geometry, 4.0 Rev 2, will be updated

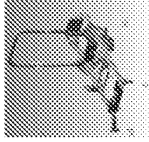
WINDCHILL/SWSW298/UPPER_LINKS_FEA.ASM

3.0	2	130-5165OLD2	LINK-UPPER
	1	130-5192	SUPPORT-CROSS OVER (MACHI
2.0	1	125-3710	LINKS/CROSSOVER.ASM (WELD
4.0	2	130-5165	LINK-UPPER (MACHI
	1	130-1132	SUPPORT-CROSSOVER, MACHIN
3.0 REV 2	2	130-5262	LOADER ARM LINK.ASM (WELD
	1	130-5269	CROSSOVER.ASM (WELDED)
4.0 REV 2	1	117-1874	UPPER LINK.ASM WELDED FUTURE

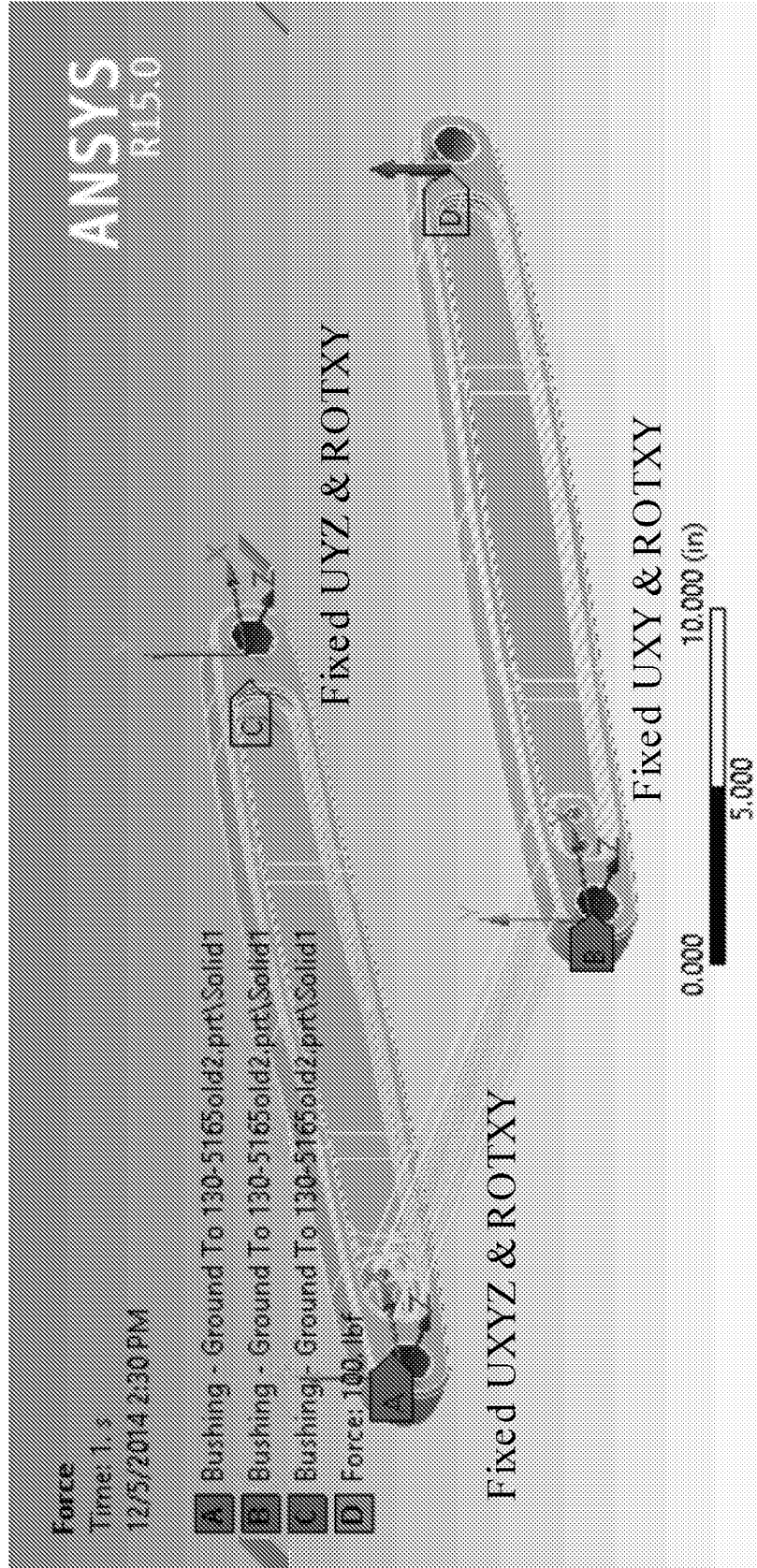
Received 12/10/2014

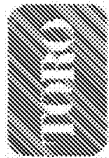


Torsional Loading

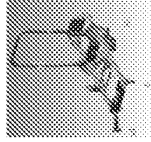


- 100 lb vertical force

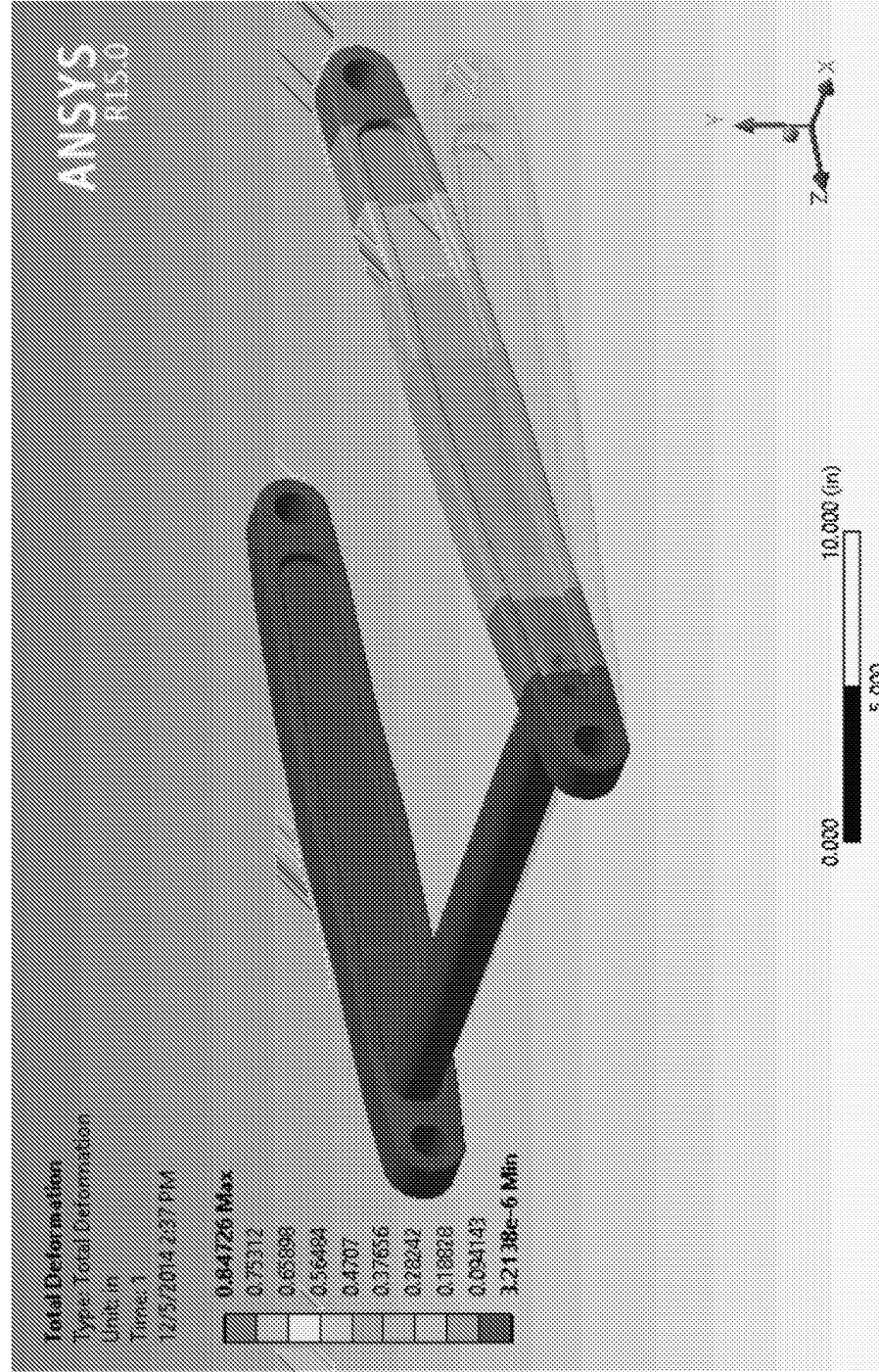




Configuration 3.0

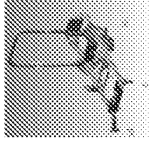


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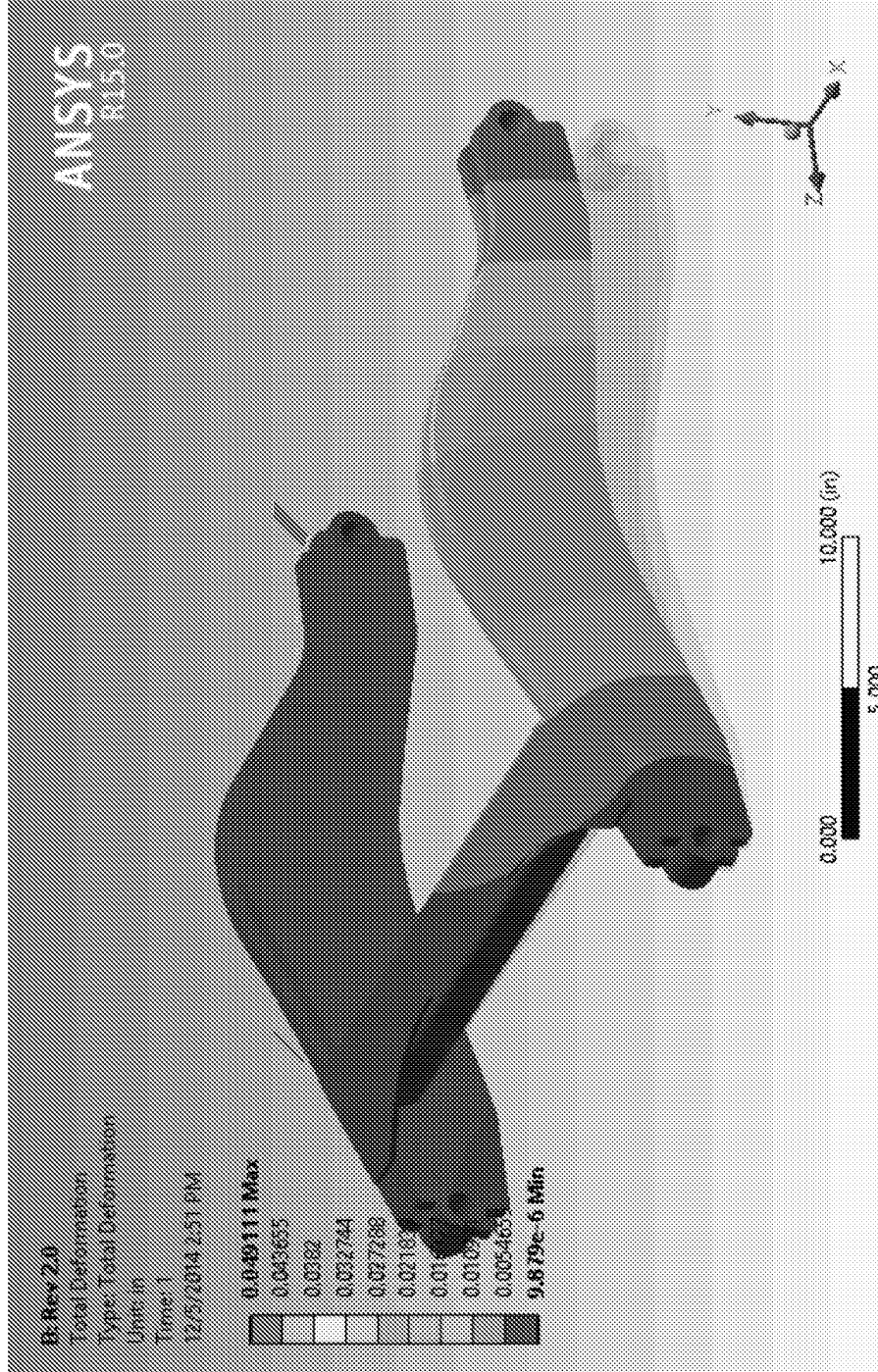




Configuration 2.0

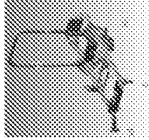


- Deflection (in)



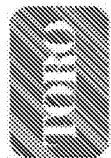


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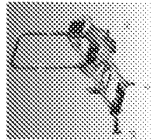


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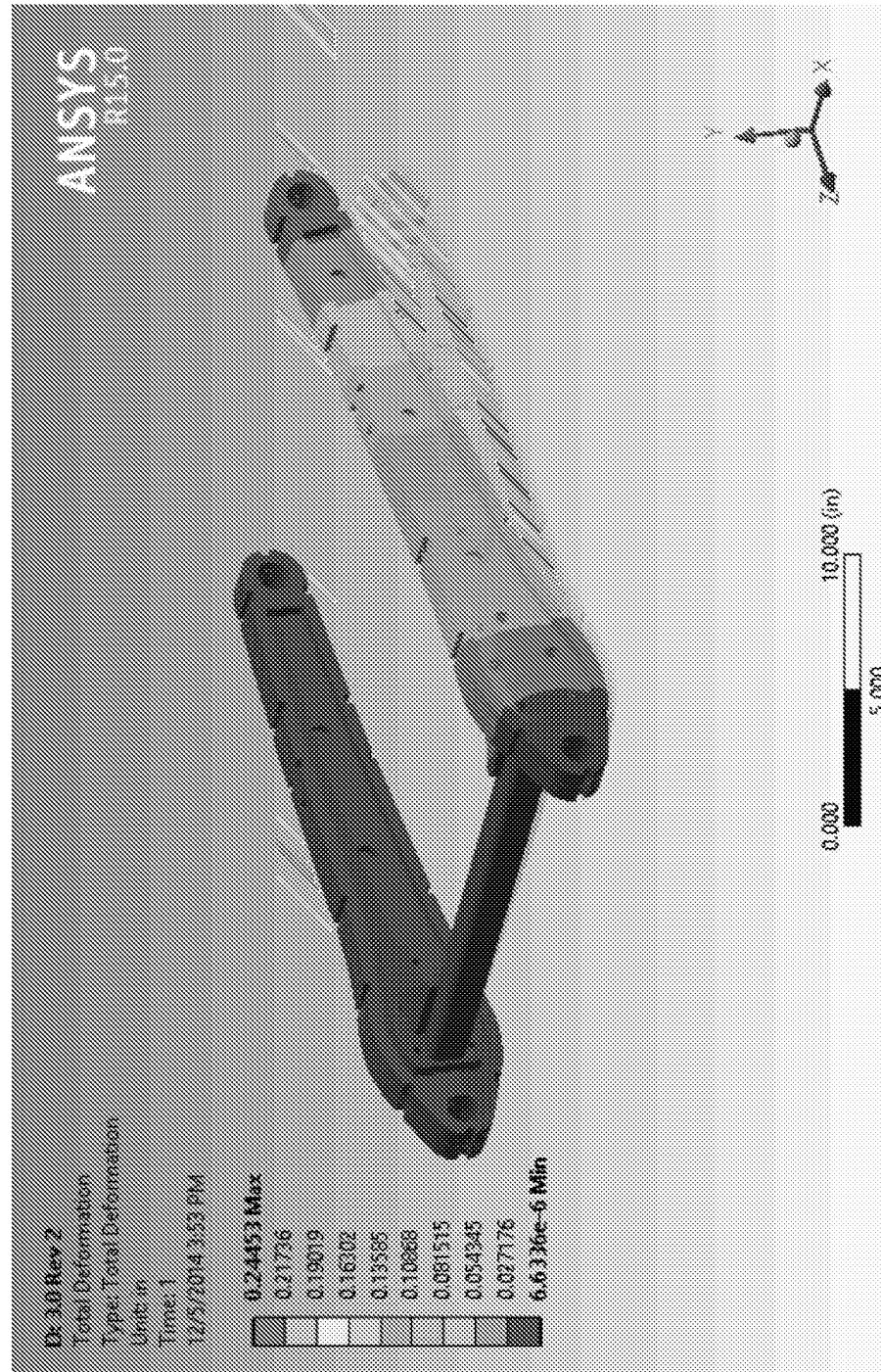


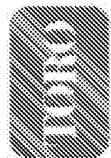


Configuration 3.0 Rev. 2



- Deflection (in)

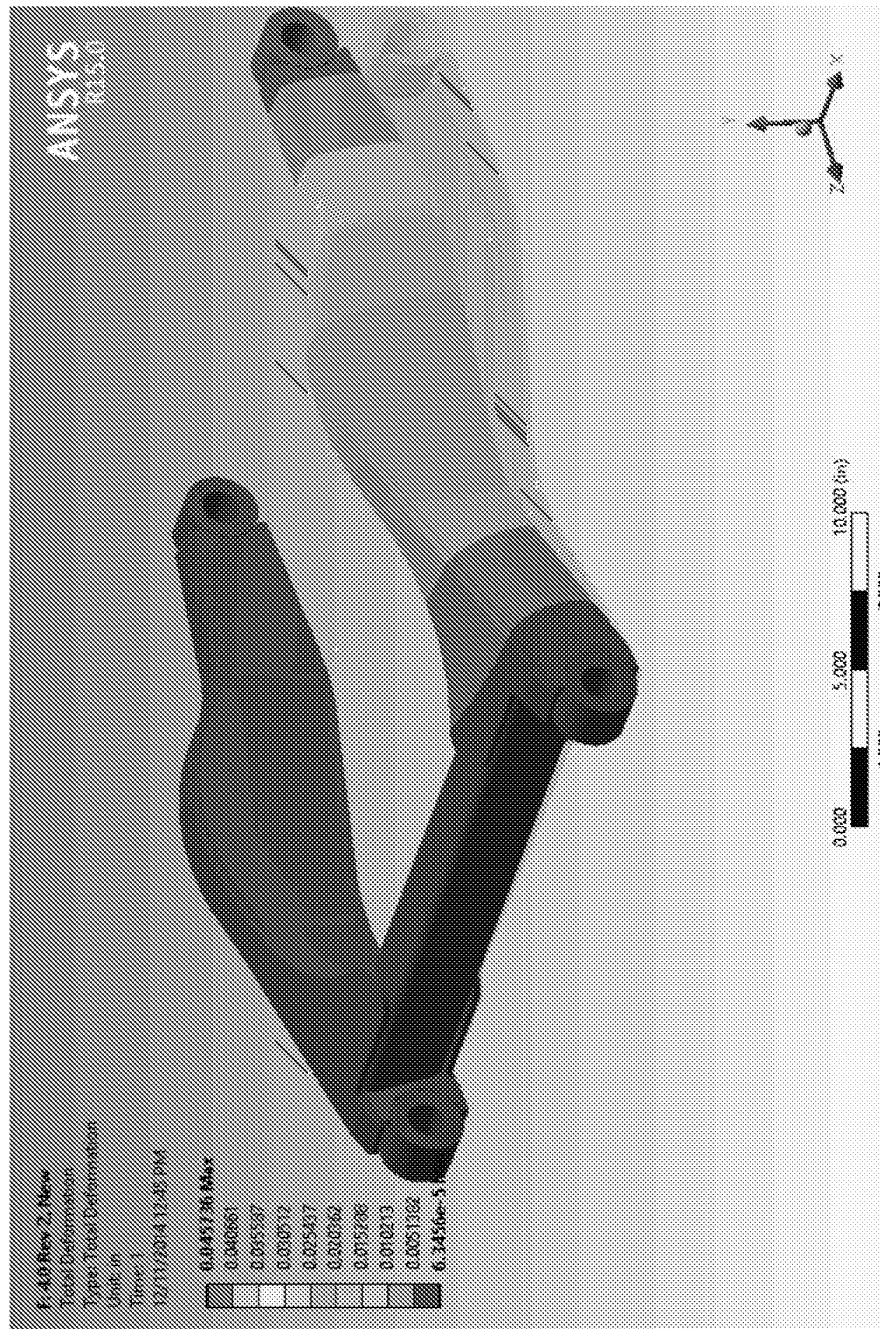




Configuration 4.0 Rev. 2

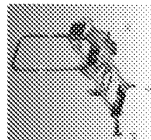


- Geometry received 12.11.2014
- Deflection (in)

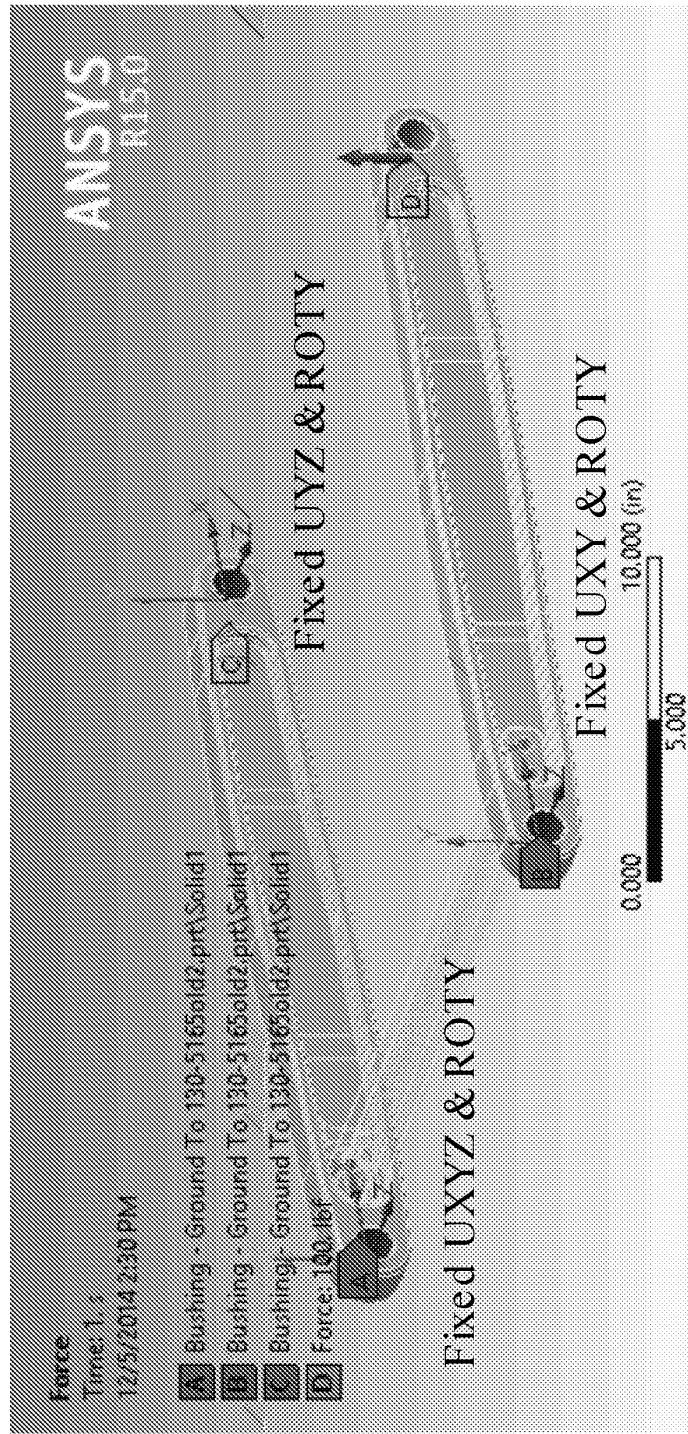




2nd Case, Torsional Loading



- Case with released ROTX (3 plcs.)
 - No pics included, but added to table of slide 10
 - 100 lb vertical force





Summary



- Deflection (in)

Configuration	Case 1 Torsional Loading	Case 2 Torsional Loading (no ROTX)
3.0	0.847	1.355
2.0	0.049	0.051
4.0	0.077	0.089
3.0 Rev 2	0.245	0.248
4.0 Rev2	0.046	0.048

2.0 Feasibility Entrance Gate Decision and Feedback

2.0 Feasibility Entrance Gate Approval Requirements

Use the calculation and matrix below to determine approval requirements.

Corporate Project Spending Approval Requirements (in Thousands)	
Project spend to date (including tooling) (in Thousands)	\$2
Spend projected to complete the Feasibility Phase (including tooling) (in Thousands)	\$495
(use this Total to determine approval level) (in Thousands) Total	\$497

Corporate Project Approval Matrix: Total		
All Amounts	Total ≥ \$250k	Total ≥ \$500k
Division Managing Director/GM	Division Managing Director/GM	Division Managing Director/GM
	Group Vice President	Group Vice President
		Managing Director, Corporate Controller
		Vice President of Finance/CFO
		Chairman & Chief Executive Officer

2.0 Feasibility Entrance Gate

W298: Next Gen TX

4/17/2013 11:36:28 AM 1

TORO-0000762

2.0 Feasibility Entrance Gate Decision and Feedback

Decision Makers	Name	Ok As-Is	OK w/Changes Noted	STOP	Rework & Return	Signature	Date
Vice President, RLC	Michael Happe						
GM Siteworks Systems	Rick Rodier						
Division Controller	Brad Mlynar						
International Controller	Mike Hall						
Marketing Manager	Neil Borenstein						
Engineering Director	Joe Hager						
Manufacturing Director	Cabrini Brandl						
National Sales Manager	Butch Greeninger						
Customer Care / Service Director	Jack Hensley						
Engineering Tech Svcs Director	Greg Tonsager						
Marketing Director, International	Mike Brugh						

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Details, 2 pgs

4/17/2013 11:36:28 AM 2

TORO-0000763

2.0 Feasibility Entrance Gate Decision and Feedback

Project Team				
Marketing Leader	Sean O'Halloran	Quality Engineer	Tony Niemczyk	
Engineering Leader	John Azure	NPD Sourcing Specialist	Randy Huerkamp	
Manufacturing	Doug Arch	Customer Care	Kevin Conney	
Advanced Manufacturing Engineer	Andrew Berglund	Test	Dave Murray	
Financial Analyst	Justin Huth			

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 1 / 2

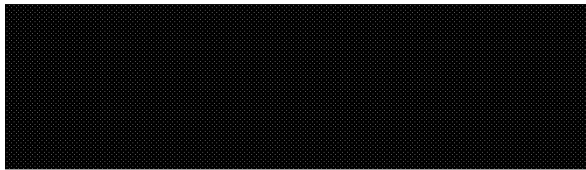
4/17/2013 11:36:28 AM 3

TORO-0000764

2.0 Feasibility Entrance Gate Decision and Feedback

Feedback

-
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-



Detail 2 / 2

W298: Next Gen TX

2.0 Feasibility Entrance Gate

8/17/2013 11:36:28 AM 4

TORO-0000765

Business and Project Strategy

Explain how this new product aligns with the business strategy and product category strategy. Describe how the market strategy will optimize the sales of this new product.

- Tracked Dingo units have been losing market share in the tracked utility loader segment. The Next Generation Dingo will create momentum for the product line and allow Toro re-gain significant market share.
- It is important to do the project now so that market share loss can be stopped and Toro can quickly gain share.
- The Next Generation Dingo project will improve upon a number of unit features so that Toro can meet, and exceed, competitors' specifications and become the #1 Compact Utility Loader of choice for contractors.

2.0 Feasibility Entrance Gate

W298: Next Gen TX

8/17/2013 11:36:28 AM 5

TORO-0000766

Project Objective

Define the specific objective of the project. Describe the purpose of the project and identify the measures and timing of project success. Include a description any constraints or nonnegotiable parameters set for this project or product that must be achieved.

- Increase Toro market share in the compact utility loader category with the introduction of the Next Generation Dingo.
- Leverage the success and innovation of the Toro Tracked Dingo units and carryover the line's reputation for performance and durability to the Next Generation Dingo.

2.0 Feasibility Entrance Gate

W298: Next Gen TX

8/17/2013 11:36:28 AM 6

TORO-0000767

Plan for obtaining the Voice of the Customer

Explain in detail how you will collect the voice of the customer data for this product and market. Include the definition of the target customer, what is now known, what is unknown, which customers you will contact, how the customers will be chosen, how the customer information will be recorded, and the timing for the research.

- VOC activities planned during Feasibility Phase
 - Interview current loyal Tracked Dingo users in all regions and continue to gather feedback on current models
 - Gather additional contractor feedback on the newest/largest Vermeer and Ditch Witch models (in addition to other competitors)
 - Gather specific feedback on the Next Gen prototype units that will be built during the Feasibility Phase
 - 1 national account customer
 - 2 current customer accounts
 - Bobcat Enterprises of Cincinnati, OH
 - 1 additional account in the mid-Atlantic region
 - Feedback from select contractors in Mpls/St. Paul area
 - (Prototype build currently scheduled to be complete 7/29/13)

2.0 Feasibility Entrance Gate

W298: Next Gen TX

8/17/2013 11:36:28 AM 7

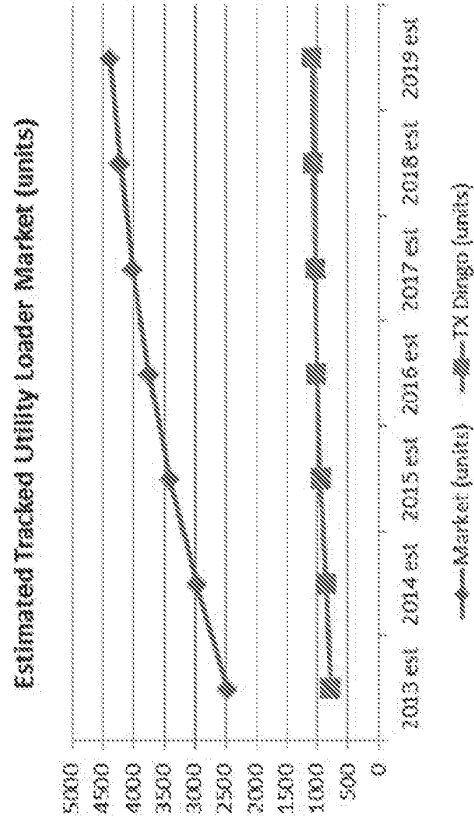
TORO-0000768

Market Estimate

Estimate the total global market size, the segments and trends. Describe growth potential and significant factors influencing the market.

- AEM provides unit data for the number of Tracked Utility Loaders sold
 - 2006 was the peak year with REDACTED units sold (U.S.)
 - 2010 experienced the lowest number of units sold with REDACTED units (U.S.)
- Category growth will continue to outpace modest Tracked Dingo product line growth without the Next Generation Dingo

REDACTED



2.0 Feasibility Entrance Gate

W298: Next Gen TX

Details: 1 page

4/17/2013 11:30:28 AM B

*Highlighting Added = CONFIDENTIAL ATTORNEYS' EYES ONLY

TORO-0000769

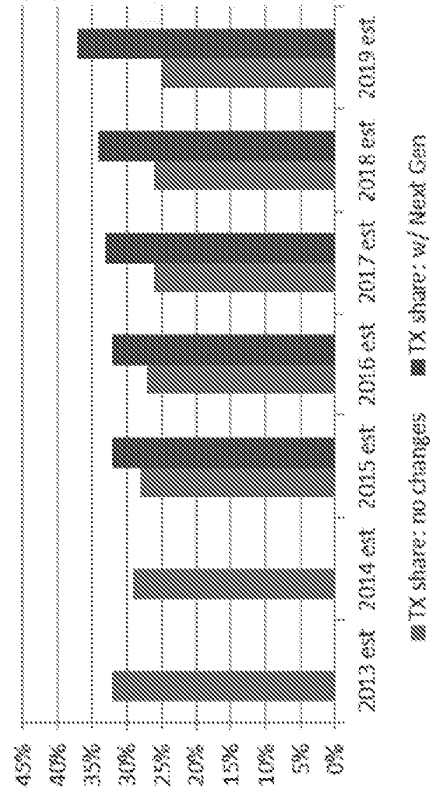
Market Estimate

Estimate the total global market size, the segments and trends. Describe growth potential and significant factors influencing the market.

- U.S. market share for Tracked Dingo units has dropped significantly since pre-2008 levels
- With availability in 2015, the Next Generation Dingo will result in increased market share and growth for the product line

REDACTED

Estimated Market Share: Tracked Utility Loaders



2.0 Feasibility Entrance Gate **W298: Next Gen TX**

Detail 1 of 1

4/17/2013 11:36:28 AM 9

*Highlighting Added = CONFIDENTIAL ATTORNEYS' EYES ONLY

TORO-0000770

Competitive Products and Services

Key the competitors and list the strengths and weaknesses of companies/brands and models that would compete with our current product and the new product. Consider services a customer may also choose as a purchasing alternative.

- Ditch Witch and Vermeer are Toro's two largest competitors in this segment. Toro continues to lose sales to these competitors because they have specifications that the tracked Toro Dingo units cannot currently match. These key specifications are:
 - Hinge Pin Height, Dump Height, and Tipping Capacity
 - (see slide on next page for a listing of specifications)

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Details, 4 pgs

8/17/2013 11:36:28 AM 10

TORO-0000771

Competitive Products and Services

vey the competitors and list the strengths and weaknesses of companies/brands and models that would
pete with our current product and the new product. Consider services a customer may also choose as a
hasing alternative.

- Lost market share is a direct result of the Tracked Dingo units being insufficient in 3 major specifications:
 - Hinge Pin Height, Dump Height, and Tipping Capacity
- The main competitors' largest units can lift more weight, lift more weight to a much greater height, and dump more weight at a much greater height

Specs	Toro				Ditch Witch		Vermeer			
	TX 427	TX 427 Wide Track	TX 525 Diesel	TX 525, Diesel Wide Track	Ditch Witch SK750 (Diesel)	Ditch Witch SK755 (Diesel)	Vermeer S450TX - Gas	Vermeer S450TX - Diesel	Vermeer S650TX - Diesel only	Vermeer S800TX - Diesel only
Unit weight without bucket (lbs)	1892	2075	1904	2001	2590	2850	2120	2300	2560	2950
Hinge pin height, max (inches)	65.8	65.8	65.8	65.8	81	81	72	72	80	84.5
Dump height, max - std. bucket (inches)	46.1	46.1	46.1	46.1	64	64	72	72	80	84.5
Reach	21.8	21.8	21.8	21.8	17	17	14.30	14.30	18.90	24.00
Tipping capacity (lbs)	1530	1530	1580	1580	2285	2285	500	500	660	840
Rated operating capacity - 35% of tipping capacity (lbs)	535	535	553	553	800	800	27	24.8	24.8	35.1
Engine Horsepower	27	27	25	35	24.8	32.8	27	24.8	24.8	35.1

*Note that Vermeer does not currently list their dump height and reach information

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 1 / 4

4/17/2013 11:36:28 AM 11

TORO-0000772

Competitive Products and Services

vey the competitors and list the strengths and weaknesses of companies/brands and models that would
pete with our current product and the new product. Consider services a customer may also choose as a
chasing alternative.

- Not being able to match or exceed these key specifications translates into some specific and very common current jobsite activities that the Toro Dingo cannot currently accomplish:
 - Dumping jobsite material into a 1 ton truck
 - Truck bed height is 41", plus 24" raised sides = 65", plus additional needed clearance room
 - Reach becomes important when dumping into a shallow truck bed
 - Dumping material into a dumpster
 - 72" dumpster height is very common

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 2 / 4

4/17/2013 11:36:28 AM 12

TORO-0000773

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 3/4

4/17/2013 11:36:28 AM 13

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000774

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 4/14

4/17/2013 11:06:20 AM -14

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000775

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Details, 7 pgs

4/17/2013 11:36:28 AM 15

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000776

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 1/17

4/17/2013 11:36:28 AM 16

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000777

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 2 / 7

4/17/2013 11:36:28 AM 17

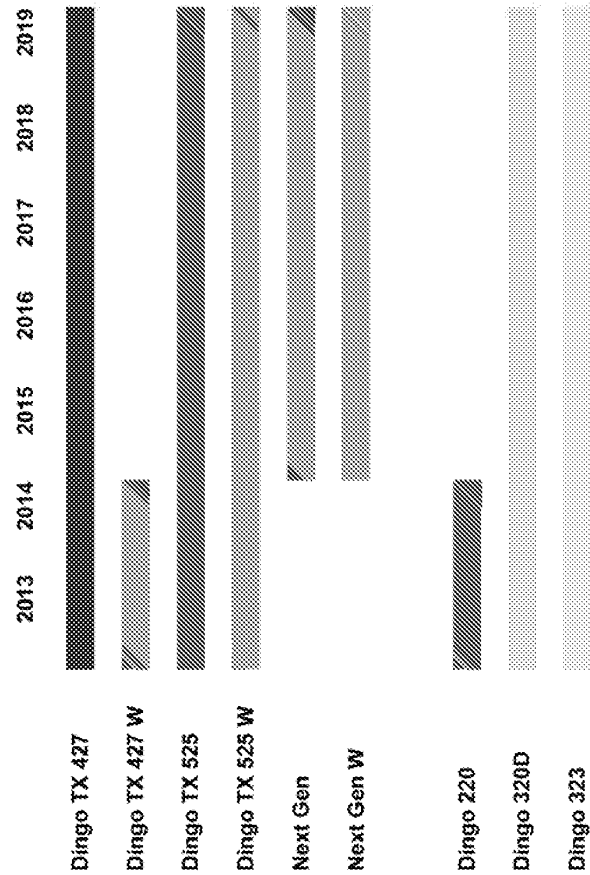
CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000778

Current Product Baseline

uate the current version the product we now sell. Establish a baseline by characterizing the total performance e existing product. Sales, product cost, customer satisfaction, production performance, sourcing, warranty and ice, and the product's performance specifications. Highlight the parameters which the new product must ove.

- 2015 Tracked Dingo offering would be:
 - 427, 525, 525W, Next Gen, Next Gen W
 - When also looking at Wheeled Dingo units this would result in 7 total Dingo models with the Next Generation launch in 2015 (same number of models as before Next Generation launch)



2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 3 / 7

4/17/2013 11:36:28 AM 16

TORO-0000779

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 4 / 7

4/17/2013 11:36:28 AM 19

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000780

Current Product Baseline

uate the current version the product we now sell. Establish a baseline by characterizing the total performance of the existing product. Sales, product cost, customer satisfaction, production performance, sourcing, warranty and service, and the product's performance specifications. Highlight the parameters which the new product must improve.

TX Customer wish list (these will not nec. be incorporated into the design but have been accumulated from years of customer feedback):

- Lift height and capacity to match the competition
 - Retain the compact design of the Dingo
- Hi-drive track
- Low operator control forces
- Ride-on platform with improved ground clearance
- Improved Qtach geometry
 - Durability / cylinder advantage
 - Increase rollback and dump
- Improved visibility to the attachment
 - Should be able to see the bucket edge when digging / grading
- Faster ground speed / variable torque traction

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 5 / 7

4/17/2013 11:36:28 AM 20

TORO-0000781

Current Product Baseline

uate the current version the product we now sell. Establish a baseline by characterizing the total performance of the existing product. Sales, product cost, customer satisfaction, production performance, sourcing, warranty and service, and the product's performance specifications. Highlight the parameters which the new product must improve.

TX Customer wish list cont...:

- Easy cleanout radiator
 - We changed screens on the Diesel TX to help with this but radiators still become plugged and compacted with debris
- Lower frame cleanout
 - Mud accumulates in the frame and corrodes the traction fittings
- Loader tower cleanout (debris gets under the cylinders)
- Track tensioner improvements
 - Dirt and mud also infiltrate the tensioning system and cause it to seize
- Improved parking brake
 - We have continually fought with the durability and action of the parking brake
- Improved track lug life
 - This has improved over the years but we have another opportunity to reduce the edges that cut the lugs

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 6 / 7

4/17/2013 11:36:28 AM 21

TORO-0000782

Current Product Baseline

uate the current version the product we now sell. Establish a baseline by characterizing the total performance of the existing product. Sales, product cost, customer satisfaction, production performance, sourcing, warranty, and the product's performance specifications. Highlight the parameters which the new product must improve.

TX Customer wish list cont...:

- Track suspension
- Low flow aux. flow option for cylinder applications
- Load sensing auxiliary
- Loader lock that does not bend the lift cylinder rod when engaged
- Improved hydraulic and engine noise characteristics
- Improved batter access (diesels)
- Improved snow performance for the track system

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 7 / 7

4/17/2013 11:36:28 AM 22

TORO-0000783

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

Key specs and features to consider on the new TX design:

- Pin Height
- Lift Capacity
- Tracks
- Controls
- Engine
- Operator Zone



Details, 11 pgs

4/17/2013 11:36:28 AM 23

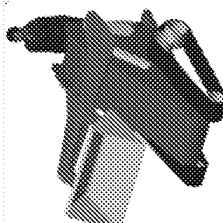
W298: Next Gen TX

2.0 Feasibility Entrance Gate

TORO-0000784

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

TX / Tmax Spec Comparison			
			
Loader		DingoTX 525	Preliminary Tmax
	Part / Feature		
	Style	Radial Lift	Vertical Lift
	Hinge Pin Height (inches)	65.8	31
	Dump Angle (degrees)	38	40-45
	Reach, Fully Raised (inches)	21.8	>21.8
Performance			
	Tip Capacity (lb)	1580	2205
	Operating Capacity (35%)	553	800
	Horsepower (hp)	25	25
	Ground speed (mph)	0-4.5 forward, 0-2 reverse	0-4.5 forward, 0-2 reverse (2-speed?)
Tracks			
	Style	Standard wrap	High Drive
	Wheel Base (inches)	31.1	34
	Ground Pressure (w/ out bucket or operator) (psi)	5.08	5.08
	Track Width (inches)	5.88	5.88

2.0 Feasibility Entrance Gate

W298: Next Gen TX

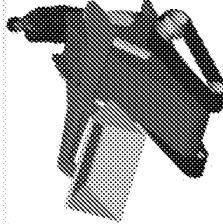
Detail 1 / 11

8/17/2013 11:36:28 AM 24

TORO-0000785

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

TX / Tmax Spec Comparison			
			
Weights and Dimensions			
	Overall Length with Bucket (inches)	92	<105
	Overall Width (inches)	33.7	33.7
	Overall height (inches)	46.1	<57
	Overall Weight without Bucket (lbs)	2001	2031
	Max. Ground Clearance (inches)	4.6	6.8
Hydraulics			
	Aux / Primary Pump (gpm)	13.8	13.8
	Loader / Secondary Pump (gpm)	5.5	5.5
	Drive Pumps (gpm)	16.9	16.9 - 21
	Drive Controls		T-Bar? - Electronic? - Piloted?
	Loader Controls	Hydrostatic T-Bar	
	Auxiliary Control	Joystick	Joystick Electronic, Capacitive?
Other Features			
	Platform	Optional fold-up	Standard fold-up

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 2 / 11

4/17/2013 11:36:28 AM 25

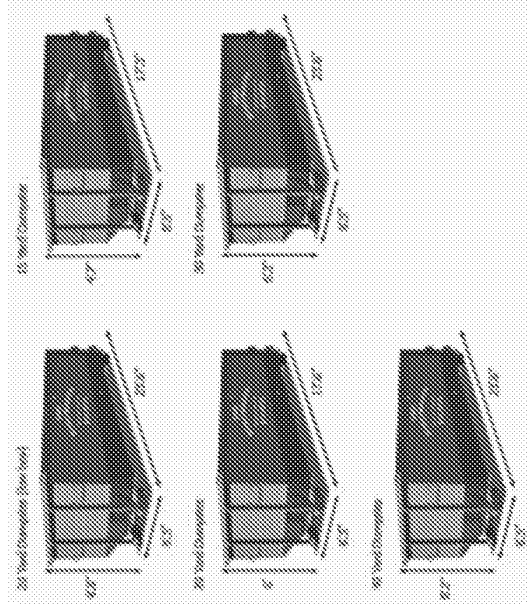
TORO-0000786

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

Pin Height

- Requirement for pin height is fairly well established
 - Dumping into a 1-ton truck (65" high bed sides)
 - Dumping into a 30-yd dumpster (75-78 inches)
- Plan is to match DW pin height of 81 inches



2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 3 / 1"

4/17/2013 11:50:28 AM 28

TORO-0000787

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

Lift Capacity

- We need to match the DW and Vermeer specs of 800 lbs (2286 lb tip)
- Loader geometry has a large impact on lift capacity
 - There are two methods to meet requirement
 - Retain radial lift loader arm and increase machine weight
 - DW and Vermeer machines are 2,900 lbs without a bucket
 - Use a vertical lift loader arm to keep the load consistently close to the machine



2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 5 / 12

4/17/2013 11:30:28 AM 26

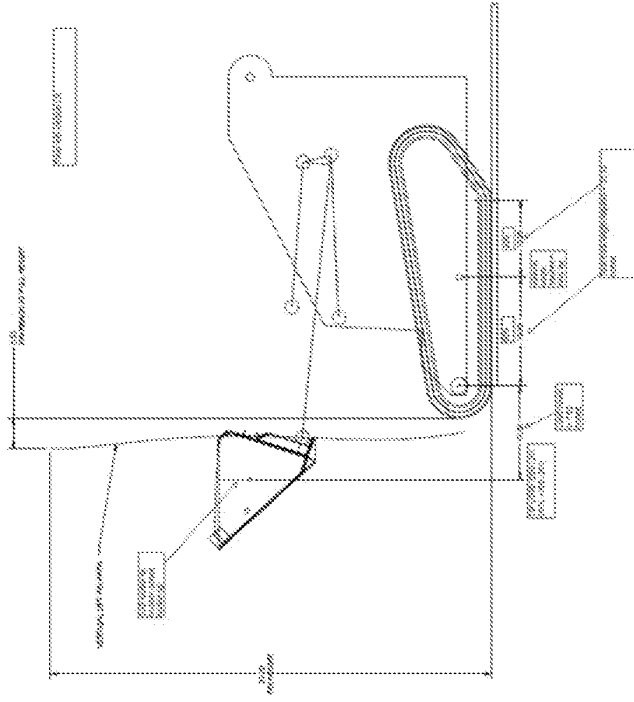
TORO-0000789

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

Lift Capacity

- We will investigate a vertical lift loader due to its advantages over a radial lift
 - Achieve needed pin height with a more compact geometry
 - Keeps the load consistently close to the machine while matching reach at full height
 - Lower machine weight is needed to lift the same amount
 - Flat lift path will make the auger drive easier to use
 - Improved dump and rollback angles



2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 6 / 11

4/17/2013 11:36:28 AM 29

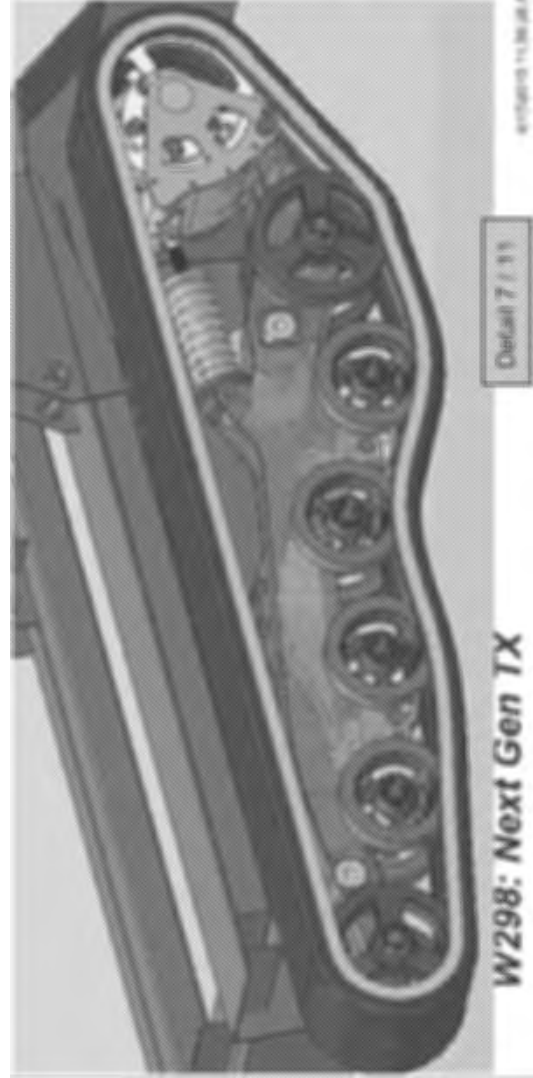
TORO-0000790

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

Tracks

- Hi-drive track improves
 - Wheelmotor loads
 - Curb jumping
 - Ground clearance
- Utilize learnings from the STX-38 track drive and the Atlas track drive designs
 - Detracking and tensioning work will be key



2.0 Feasibility Entrance Gate

entrypoint to detail 138 30

TORO-0000791

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

Tracks

- Retaining current ground pressure spec is affected by overall machine weight and track length
- Maximum machine weight to retain ground pressure with the STX-38 track is 2031 lbs

Narrow Track Ground Pressure				
	Track Width (in)	Track Length (in)	Weight, unit only (lbs)	Ground Pressure (PSI)
Current TX	5.88	31.50	1882	5.08
	5.88	35.15	2100	5.08
	5.88	39.34	2350	5.08
	5.88	43.52	2600	5.08
	5.88	47.71	2850	5.08
Ditch Witch 516750	7.00	43.00	2890	4.90
Wide Track Ground Pressure				
	Track Width (in)	Track Length (in)	Weight, unit only (lbs)	Ground Pressure (PSI)
Current TX	9.50	31.50	1990	3.32
	9.50	32.33	2150	3.50
	9.50	36.09	2400	3.50
	9.50	39.85	2650	3.50
	9.50	43.61	2900	3.50
Ditch Witch 755	9.00	43.00	2940	3.20
Vermeer 800	9.00	46.00	2950	3.56

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 8 / 17

4/17/2015 11:50:28 AM 31

TORO-0000792

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

Controls

•We will investigate control methods and styles in the 2.0 stage

•Considerations:

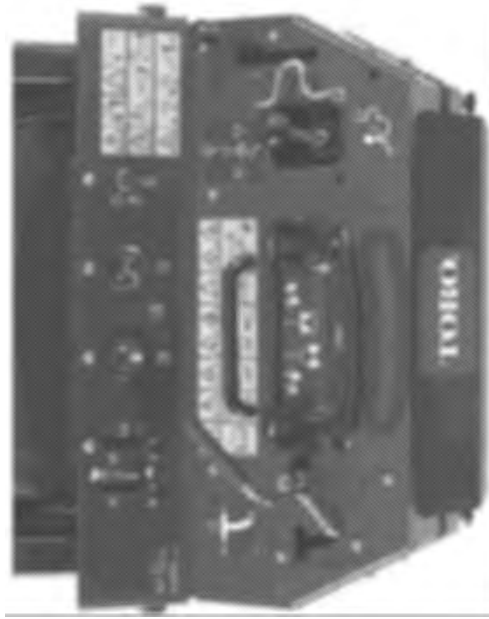
- Ease of use
- Control forces / control stroke
- Stand-on / ride-on / hang-on

•Methods

- Manual (current)
- Pilot operated (DW and Vermeer)
- Electronic proportional

•Styles

- T-bar (current)
- Joystick (DW and Vermeer)
- Steering wheel
- Other?



2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 9 / 12

4/17/2018 11:30:28 AM 32

TORO-0000793

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

Engine

- Tier IV likely limits hp options to sub-25hp (current Kubota 902 engine)
- We will investigate higher diesel hp options in the 30-35 hp range for expense and size
 - Kohler
 - JCB
 - Yanmar
- We will also investigate high hp gas EFI engines (Kohler)

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 10 / 11

4/17/2013 11:36:28 AM 33

TORO-0000794

Solution Alternatives

List possible product design ideas or service solutions. Do not let feasibility constraints limit you. For each solution or idea, note the benefits and limitations, from the customer perspective. Stretch for innovation.

Operator Zone

- Investigate a fold-up platform with improved ground clearance over the current TX (4-8 inches)
 - Fold-up option makes the machine more compact for trailering
 - Walk behind option makes the unit safer and easier to use in tight spaces and on grades
- A balance will have to be found between control height and platform ground clearance (adjustable control height?)



2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 11 / 11

8/17/2013 11:36:28 AM 34

TORO-0000795

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Details, 4 pgs

4/17/2013 11:36:28 AM 35

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000796

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 1/4

4/17/2013 11:36:28 AM 36

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000797

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 2/14

4/17/2013 11:06:28 AM 37

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000798

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 3/4

4/17/2013 11:36:28 AM 38

CONFIDENTIAL - ATTORNEYS' EYES ONLY

TORO-0000799

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 4 / 4

4/17/2013 11:36:28 AM 38

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TORO-0000800

Project Investment

Estimate the project investment by fiscal year and by phase. Update projections and actual at each Gate.

Project Investment by Phase						
Dollars in Thousands (\$,000.)	Concept Phase	Feasibility Phase	Development Phase	Mid-Development Phase	Mfg Pilot Phase	Total
Original Estimate						
Current Projection		497	995	218	192	1,902
Actual						
Variance		497	995	218	192	1,902
Original Estimate						
Current Projection			125	125		250
Actual						
Variance			125	125		250
Original Estimate						
Current Projection			100	100		200
Actual						
Variance			100	100		200
Original Estimate						
Current Projection						
Actual						
Variance						
Original Estimate						
Current Projection		497	1,220	443	192	2,352
Actual						
Variance		497	1,220	443	192	2,352

Details, 4 pgs

887772013410271146 43

TORO-0000801

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 1/4

4/17/2013 11:36:28 AM 41

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TORO-0000802

Project Investment

Estimate the project investment by fiscal year and by phase. Update projections and actual at each Gate.

PJ2 F13 PLAN SWS Core Group	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Totals
Project													
W258 - SWS R&D	\$17,093	\$8,333	\$4,167	\$4,167	\$7,251	\$7,251	\$7,251	\$7,251	\$7,251	\$7,251	\$7,251	\$7,251	\$75,106
W261 - Dingo TX DCI	\$16,901	\$24,807	\$36,558	\$35,386	\$20,571	\$19,286	\$20,226	\$19,538	\$20,688	\$21,088	\$23,488	\$21,538	\$280,076
W263 - Admin Allocation	\$8,993	\$8,993	\$8,993	\$8,993	\$8,993	\$8,993	\$8,993	\$8,993	\$8,993	\$8,993	\$8,993	\$8,993	\$106,717
W264 - International Allocation	\$22,917	\$22,917	\$22,917	\$22,917	\$22,917	\$22,917	\$22,917	\$22,917	\$22,917	\$22,917	\$22,917	\$22,917	\$275,004
W280 - SWS Cost Reduction	\$476	\$1,036	\$1,429	\$4,514	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$7,456
W281 - Field Test Allocation	\$1,546	\$1,537	\$1,537	\$1,537	\$1,537	\$1,537	\$1,537	\$1,537	\$1,537	\$1,537	\$1,537	\$1,537	\$18,454
W287 - 35hp STX/Other Large Machine	\$48,321	\$41,896	\$30,877	\$9,110	\$8,300	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$121,905
W293 - Atlas	\$0	\$0	\$476	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$476
W297 - Hold Backs	\$0	\$0	\$0	\$0	\$8,375	\$8,375	\$8,375	\$8,375	\$8,375	\$8,375	\$8,375	\$8,375	\$67,000
W298 - Next Gen TX	\$0	\$737	\$1,627	\$6,693	\$60,513	\$98,496	\$77,378	\$76,737	\$88,020	\$79,934	\$71,674	\$59,822	\$621,631
W299 - TRX-38 Trencher	\$19,123	\$864	\$2,824	\$11,052	\$12,109	\$2,634	\$0	\$0	\$0	\$3,991	\$8,068	\$10,541	\$71,206
Totals	\$89,438	\$48,520	\$65,471	\$58,435	\$88,032	\$123,555	\$100,743	\$99,415	\$111,848	\$108,152	\$106,369	\$95,044	\$1,095,022

PJ2 Plan refocuses spending from Atlas and the Trencher project into project W298

Some spending is retained under W299 to rebuild the TRX38 and begin work at the end of the year

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 2 / 4

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TORO-0000803

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 3/14

4/17/2013 11:36:28 AM 43

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TORO-0000804

REDACTED

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 4/14

4/17/2013 11:36:28 AM 44

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TORO-0000805

Prototype Plan and Results

Describe the plan and the estimated schedule for prototypes to be built and tested. Report results of prototypes that have been built.

2.0 Stage (Build on 7/23/13)

- Build 3 prototypes

- 2 narrow track units
- 1 wide track unit

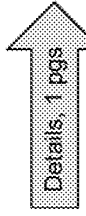
- Usage

- 1 unit for lab work
- 1 unit for field / performance work
- 1 unit dedicated to VOC

- Units may have a mixture of engines (gas-diesel) depending on project direction

2.0 Feasibility Entrance Gate

W298: Next Gen TX



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TORO-0000806

Prototype Plan and Results

Describe the plan and the estimated schedule for prototypes to be built and tested. Report results of prototypes that have been built.

3.0 Stage (Prototypes built 3/18/14)

- Build 5 prototypes
 - (1) for Lab
 - (2) for Field
 - (1) for Marketing
 - (1) for Mfg

4.0 Stage (Updates after 500 hours on the 3.0)

- Any updates required (permanently tooled parts for example) will be fit onto the 3.0 machines after initial field testing is complete

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Detail 1 / 1

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TORO-0000807

Project Schedule and Milestones

List the milestones and dates that are critical to achieve the planned project schedule.

Milestone Dates	Plan	Actual	Comments
2.0 Approval	3/11/13		
2.0 Prototype Build Completed	7/29/13		Build 3 prototypes for qualification and VOC work
3.0 Signoff	11/4/13		Allows 12 weeks for VOC and qualification work
3.0 Prototype Build Completed	3/18/14		
Long Lead / Tooling Releases	7/31/14		
4.0 Signoff	8/6/14		
4.0 Updates	9/3/14		Bring units in for updates after 500 field hours
5.0 Signoff	11/6/14		
Pilot Build Completed	11/19/14		4.0 qualification completed by this date
Production	1/15/15		
Release to Ship	1/29/15		Product fully released and available for Rental Show
2.0 Feasibility Entrance Gate	W298: Next Gen TX		

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TORO-0000808

Feasibility Phase Critical Actions

List the most critical actions the team needs to complete in the Feasibility Phase for this project to fully satisfy the stated project objectives.

Marketing

- Thoroughly investigate market share loss
 - As previously indicated, market share loss is a result of being out-spec'd by competitors
 - Competitor pricing is also affecting market share loss
 - Formal market research will be conducted during the Feasibility Phase to understand the importance of price in the purchase decisions of Ditch-Witch users (to what degree price is influencing purchase decisions), price elasticity, and the importance of product specs relative to price.

•Cost reduction efforts

- Work with the team to ensure all Dingo TX BOM items are reviewed for cost reduction opportunities (cost reduction opportunities for current models and eventual Next Gen models)
 - Dingo TX BOMs are currently being reviewed
 - 1 current cost reduction opportunity: current wide drive track wheel cost is **REDACTED**

•Continue ROI analysis

- Prototype review and agreement on product specifications
 - Specifications to be based on VOC and internal results
- More detailed competitive analysis based on user feedback

Engineering

- Purchase a Vermeer 800 or DW 750 for competitive evaluations
- Finalize all key specs and design features
- Build three prototypes for VOC work and performance evaluations

2.0 Feasibility Entrance Gate

W298: Next Gen TX

Details, 1 pgs

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*Highlighting Added = CONFIDENTIAL ATTORNEYS' EYES ONLY

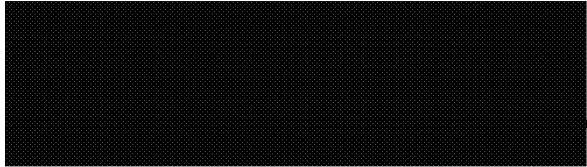
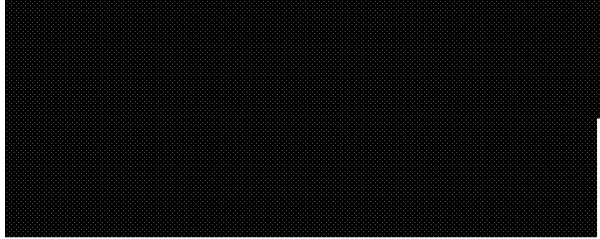
TORO-0000809

Feasibility Phase Critical Actions

List the most critical actions the team needs to complete in the Feasibility Phase for this project to fully satisfy the stated project objectives.

Engineering (continued)

- Begin preliminary qualification work on key new design areas
 - Lift capacity and other loader characteristics
 - Engine and hydraulic performance and cooling
 - Track performance and detracking
 - Operator controls
- Determine product and project costs for the 3.0 approval
- Review standards and develop a test plan for the 3.0 approval
- Investigate patent opportunities



Detail 1 / 1

W298: Next Gen TX

2.0 Feasibility Entrance Gate

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TORO-0000810

Project Risks and Risk Management Plan

List the risks that may limit the project from achieving the goal. Consider all aspects including: marketing, competition, distribution, quality, performance, price, design, supply, etc. For each risk state the impact, the likelihood of occurring, the mitigation actions to prevent the occurrence and the contingency plan if it occurs.

Priority	Risk	Likely To Occur	Impact	Mitigation Actions	Contingency Actions
Rank	What is the issue that may impact the project?	High Medium Low	If it occurs how will it effect the project?	What are the actions being taken to prevent the occurrence or minimize the impact?	If the Risk does occur what actions will the team take?
1	Missing target costs due to expense of desired product features	High	Results in uncompetitive pricing or a product that does not meet customer requirements	Utilizing innovation like vertical lift to keep machine weight and corresponding costs down. Initiate DFMA activities as early in the design process as possible.	Compromise on product features to keep cost in balance
2.0 Feasibility Entrance Gate			W298: Next Gen TX		

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TORO-0000811

Competitive Product Evaluation

Provide an objective and comprehensive evaluation of competitive products available to the customer, including our product that is now in the market. Consider the total product including: performance, quality, marketing message, serviceability, ease-of-operations, appearance, finish, packaging, availability, specification statements, etc.

Tracked CULs	Toro		Toro		Toro		Ditch Witch		Vermeer	
	NextGen W TX	NextGen N TX	525W TX	525W TX	SK 750/755	S650 TX	S600 TX			
Tipping capacity (lbs)	3,070	2,857	1,580		2,285	1,890	2,400			
Rated operating capacity (35% of tip)	1,075	1,000	553		800	660	840			
Hinge pin height (inches)	81	81	66		81	80	84.5			
Horsepower (gross rating)	24.8	24.8	24.8		24.8 / 32.8	24.8	35.1			
Max ground speed - forward (mph)	4.7	4.7	4.0		4.7	4.5	4.5			
Max ground speed - reverse (mph)	4.7	4.7	2.0		4.7	4.5	4.5			
Machine weight (lbs)	2,633	2,450	2,001		2,890	2,560	2,950			

- Next Gen vertical lift loader arm design is a key differentiator
- Next Gen 1,000+ lb. rated operating capacity is unprecedented
 - Next Gen (wide) rated operating capacity is 28% greater than Vermeer's
- Next Gen units will weigh significantly less than Ditch Witch and Vermeer's largest units
 - Next Gen (wide) will weigh 317 lbs. less than Vermeer S800 TX
 - Doing more with a machine that has a lighter footprint

3.0 Development Entrance Gate

W298: Next Gen TX

Details, 5 pgs

6/30/2014 9:53:59 AM 16

TORO-0000854

Proposed Solution

Describe in detail the recommended solution that best meets the customer needs and the business needs. Identify the fundamental system and sub-system alternatives that must be considered, and state why this choice is preferred.

Key Features that innovate and “leapfrog” the competition

- Vertical lift loader design
 - Outperform the competition on lift capacity while retaining a smaller, more compact machine
 - 1000 lb operating capacity from a sub-2,500 lb machine
- Toro all-rubber track system
 - Retain the advantages of the Dingo track design vs. a Bridgestone track system
- Toro-designed operator controls
 - Eliminate the shortcomings of the competitive designs and retain Toro’s leadership in control systems
- Toro designed electronic module
 - First introduction of “smarts” in the Dingo product line
 - Will integrate warning switches, automate the glow plug and provide interlock logic for the machine

Project Risks and Risk Management Plan

List the risks that may limit the project from achieving the goal. Consider all aspects including: marketing, competition, distribution, quality, performance, price, design, supply, etc. For each risk state the impact, the likelihood of occurring, the mitigation actions to prevent the occurrence and the contingency plan if it occurs.

Priority	Risk	Likely To Occur	Impact	Mitigation Actions	Contingency Actions
Rank	What is the issue that may impact the project?	High Medium Low	If it occurs how will it effect the project?	What are the actions being taken to prevent the occurrence or minimize the impact?	If the Risk does occur what actions will the team take?
1	Missing target costs due to expense of desired product features	High	Results in uncompetitive pricing or a product that does not meet customer requirements	Utilize VOC feedback to decide which new features can be downgraded; Reduce machine weight; DFMA review of major components and systems	Revise specs and features to further reduce weight and cost
2	Loader arm complexity and durability results in failures	High	Increased weight, cost, and time to develop the arm	Iterative rounds of FEA in the 2.0 phase to address problem areas	Revise and reinforce loader design

3.0 Development Entrance Gate

W298: Next Gen TX

Details, 1 pgs

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TORO-0000894

4.0 Mid-Development Entrance Gate Decision and Feedback

4.0 Mid-Development Entrance Gate Approval Requirements

All Amounts : Division Managing Director/GM

Decision Makers	Name	Ok As-Is	OK w/Changes Noted	STOP	Rework & Return	Signature	Date
General Manager, SWS	Rick Rodier						
Division Controller	Brad Mlynar						
Marketing Director	Neil Borenstein						
Engineering Director	Joe Hager						
Manufacturing Director	Cabrini Brandl						
Sales Director	Butch Greeninger						
Customer Care / Service Director	Jack Hensley						
Engineering Tech Svcs Director	Greg Tonsager						
Sr. Marketing Mgr, International	Michael Brugh						

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

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TORO-0000929

4.0 Mid-Development Entrance Gate Decision and Feedback

Project Team				
Marketing Leader	Sean O'Halloran	Quality Engineer		Tony Niemczyk
Engineering Leader	John Azure	NPD Sourcing Specialist		Randy Huerkamp
Manufacturing	Scott Vollmer	Customer Care		Kevin Conney
Advanced Manufacturing Engineer	Andrew Berglund	Test		Dave Murray

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Details: 2 pgs

2/20/2015 8:10:10 AM 2

TORO-0000930

4.0 Mid-Development Entrance Gate Decision and Feedback

Feedback

-
-
-
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-
-

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 1 / 2

2/20/2015 8:10:10 AM 3

TORO-0000931

W298 FEASIBILITY FEEDBACK

Happo - Next Gen TX 2.0 Feedback

• Need 3.0 on project update at \$500M follow for this project

- In addition to the market share gain, we need to see gross margin on the next Gen Dingo slightly improved. It is important we drive the Core S&S product category CRR to double digit yield.
- Have a specific mkt share goal. \$1 is nice but may not always equate to rising market share. We should consider 40% w/in-tracked utility/leaves.
- Vol w/non-Dingo customer critical to achieving growth.
- How do we define a new specification category if we can deliver significant innovations? We have to maintain meaningful differentiation so we don't lose a spec war in the future. What customer problems will we solve that no one else does or can? Which links drive incremental improvements; problems drive value
- Good quality results on current Dingo - can't go backwards.
- Conduct key area to investigate for differentiation —> smarter, intuitive
- Price-to-market (street) value —> should make sense to our up-sell
- Target financial improvements: **REDACTED**
- Is there any part of NGTX project spending that is helpful for the Atlas product?
- Are there any Operational targets: Draw, Parts cost, ^{freight cost, etc to} ~~consider~~ Consider

Detail 2/2

W298: Next Gen TX

4.0 Mid-Development Entrance Gate

*Highlighting Added = CONFIDENTIAL ATTORNEYS' EYES ONLY

TORO-0000932

27/02/15 E-10-10 A38 4

Business and Project Strategy

Explain how this new product aligns with the business strategy and product category strategy. Describe how the market strategy will optimize the sales of this new product.

- Successfully expand the Dingo product line offering with the introduction of the TX 1000 Narrow Track and Wide Track units
 - Next Gen units will be additions to the existing TX line
 - Existing units have significant value, in both the dealer and rental channels
- Become #1 Compact Utility Loader of choice for contractors and Rental
 - Meet, and exceed, competitor specifications and incorporate key features
 - Greatest rated operating capacity (1000 and 1075 lbs) in the CUL category
 - 81" hinge pin height to clear 30 yard dumpsters and one ton truck with 24" sideboards
 - High drive track system
 - High max travel speed in forward (4.7 mph) and reverse (4.7 mph)
 - Intuitive and differentiated traction controls
- Re-establish Toro as the CUL market leader
 - Toro invented the category, and Toro is re-inventing the category through TX 1000 product innovation
 - Vertical lift loader arm design and traction controls

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Details: 1 pgs

2/20/2015 8:10:10 AM 5

TORO-0000933

Business and Project Strategy

Explain how this new product aligns with the business strategy and product category strategy. Describe how the market strategy will optimize the sales of this new product.

- Grow market share
 - Toro tracked CUL share grew slightly in 2014 (31% through Nov); the strategy is to gain significant share
 - Obtain 38% market share in 2019 (as measured by AEM, units shipped)
- Protect margin and profit
 - TX 1000 units will feature lower margin than current TX products
 - Team has a cost reduction action list for TX 1000 items

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

Detail 1 / 1

2/20/2015 8:10:10 AM 6

TORO-0000934

Project Objective

Define the specific objective of the project. Describe the purpose of the project and identify the measures and timing of project success. Include a description any constraints or nonnegotiable parameters set for this project or product that must be achieved.

- Introduce Dingo TX 1000 models that:
 - are differentiated from competitor units
 - have key specs and capabilities that are greater than competitor units
 - better meet end-user product requirements, for both professional contractors and rental customers
- Increase Toro market share in the tracked compact utility loader category
 - Achieve 38% market share in 2019
- Project success will be measured by:
 - Successful launch and introduction at the ARA show - February 23-25
 - Securing orders for a minimum of 200 units before the end of March (in advance of anticipated June/July shipments)
 - Market share gain, 32.3% share by the end of 2015

4.0 Mid-Development Entrance Gate

W298: Next Gen TX

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TORO-0000935

Customer Feedback

Identify customers from whom feedback was received. Explain in detail the specific feedback the customers provided. Describe the actions that will be taken to respond to the feedback.

- Customers provided traction controls feedback regarding:
 - Intuitiveness of controls and ease of operation
 - Control design and ergonomic preferences
 - Level of operator strain/fatigue
 - Machine responsiveness when changing direction
- Customers also provided input regarding
 - General impressions of the 3.0 units
 - (Most of these customers had previously reviewed the 2.0 machines)

Name	Company
Charlie Kraemer	Landscape Charlie
Bill Jorgensen	Landscapes by Lora
Evan Jorgensen	Landscapes by Lora
Jack Evans	Natural Elements Lawn and Landscape
Simon Huxtable	Patio Plus LLC, owner
Mike Hart	Beds and Borders Landscape and Design
Andrew Riegert	Natural Surroundings Landscape and Design
Cory Unterschuetz	Cities Edge Landscaping
Dean Bjorkstrand	Bjorkstrand, Inc. Landscaping
David Titus	Sunbelt Rentals
Jeff Reid	BlueLine Rental
John McVeigh	BlueLine Rental



W298: Next Gen TX

4.0 Mid-Development Entrance Gate

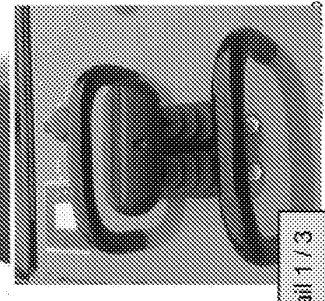
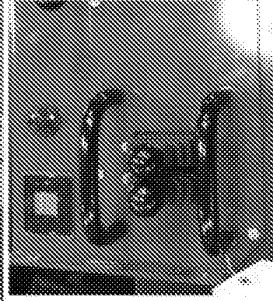
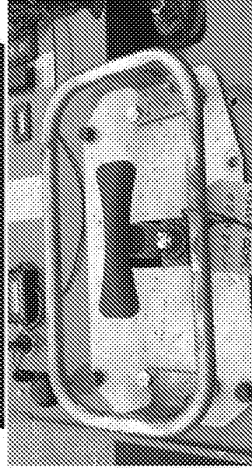
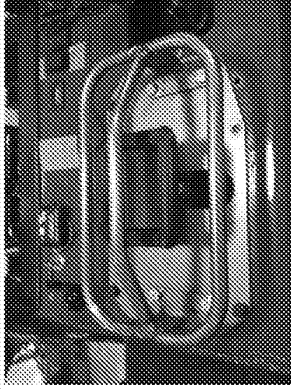
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Customer Feedback

Identify customers from whom feedback was received. Explain in detail the specific feedback the customers provided. Describe the actions that will be taken to respond to the feedback.

- #1 Shrunk-down TX control
 - Control was too large and too bulky
 - Reference bar did not sync up well with control
 - Not comfortable, difficult to operate
- #2 Dog-bone
 - Similar to Bobcat's style
 - Too much twisting required for basic movements
 - Not ideal for turning
 - Contributed to operator fatigue
- #3 Two-levers
 - Similar to Ditch Witch controls (viewed positively by DW owners)
 - Intuitive, easy, simple, effortless
 - Not ideal for tight turns, and difficult to go straight in reverse
- #4 TX 1000 traction controls
 - Intuitive, easy, effortless, simple
 - (Additional info on the next slide)



Detail 1 / 3

4.0 Mid-Development Entrance Gate

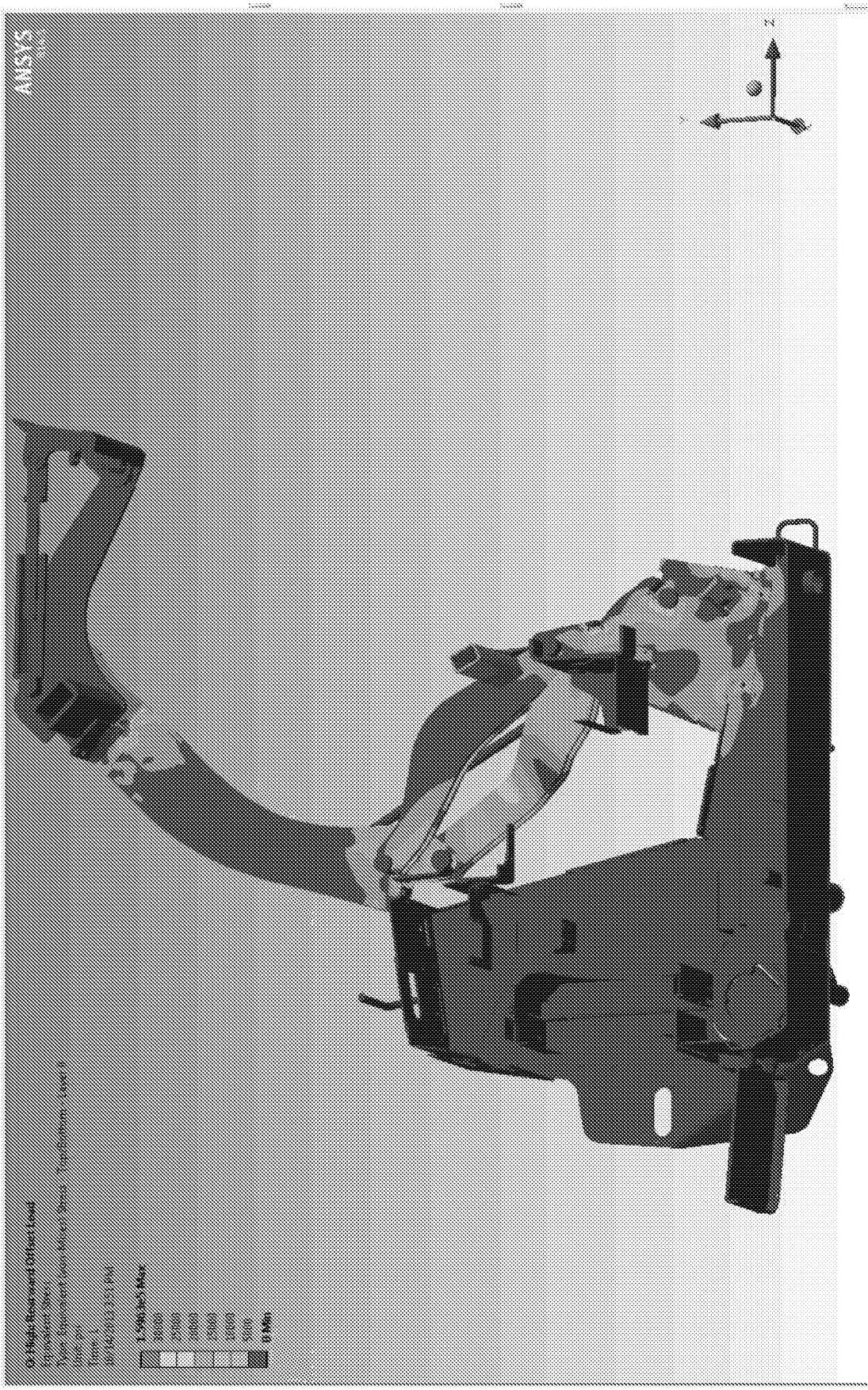
W298: Next Gen TX

TORO-0000937

Load Case 3, High Position



Load Case 4, High Position



Inside cutaway view

ANSYS

High-Resolution Output Load
Equivalent Stress
Type: Equivalent (von-Mises) Stress - Typical
Unit: psi
Scale: 0
Min: 0
Max: 81963722.0 (1E+09)
81963722.0 (1E+09)
81963722.0 (1E+09)
81963722.0 (1E+09)
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81963722.0 (1E+09)

Load Case 5, High Position

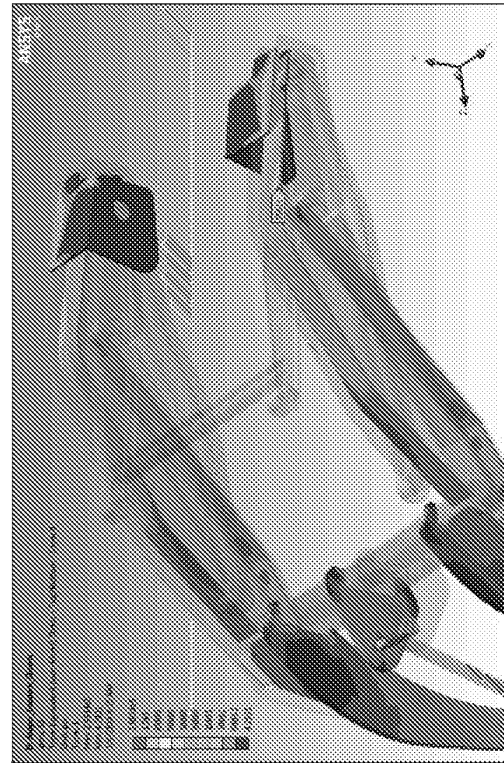
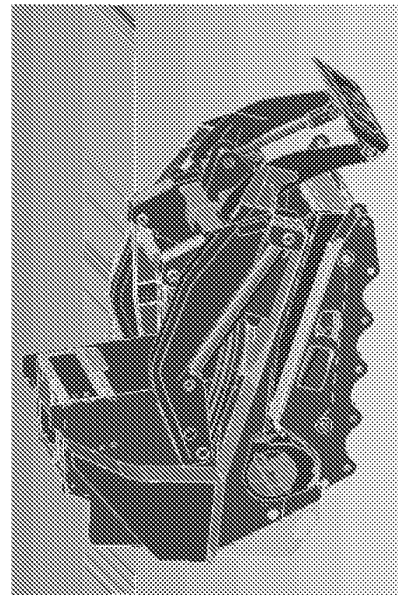


Load Case 5, High Position





TMAX Loader Arm Plates 03/06/2014

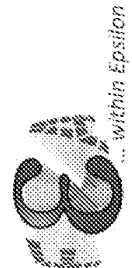
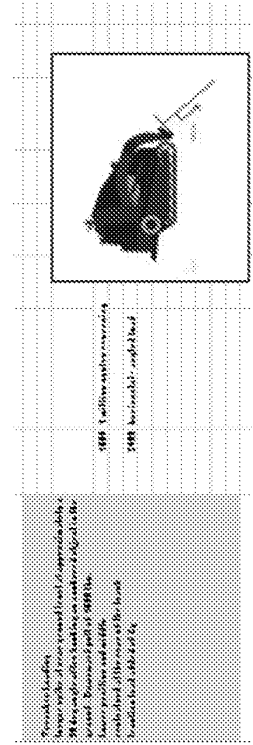
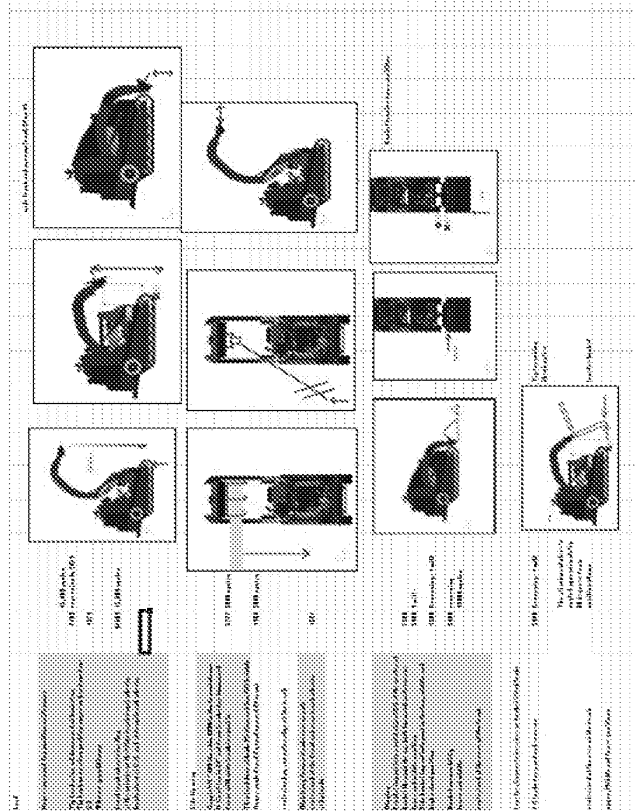




21 Load cases



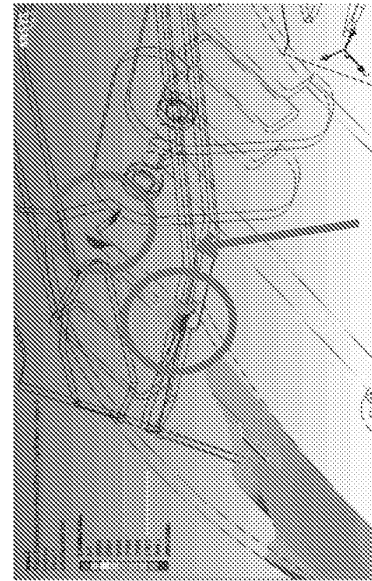
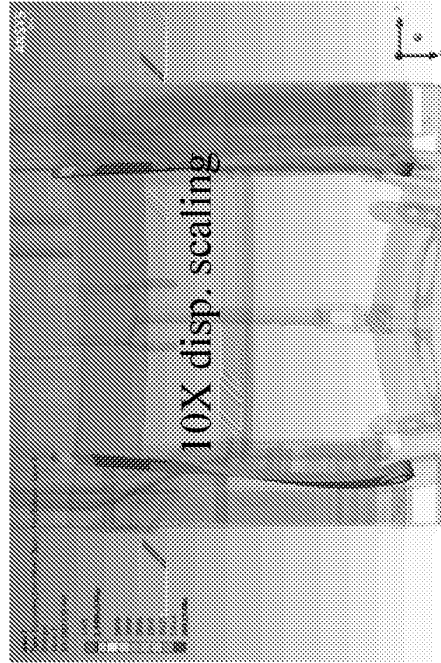
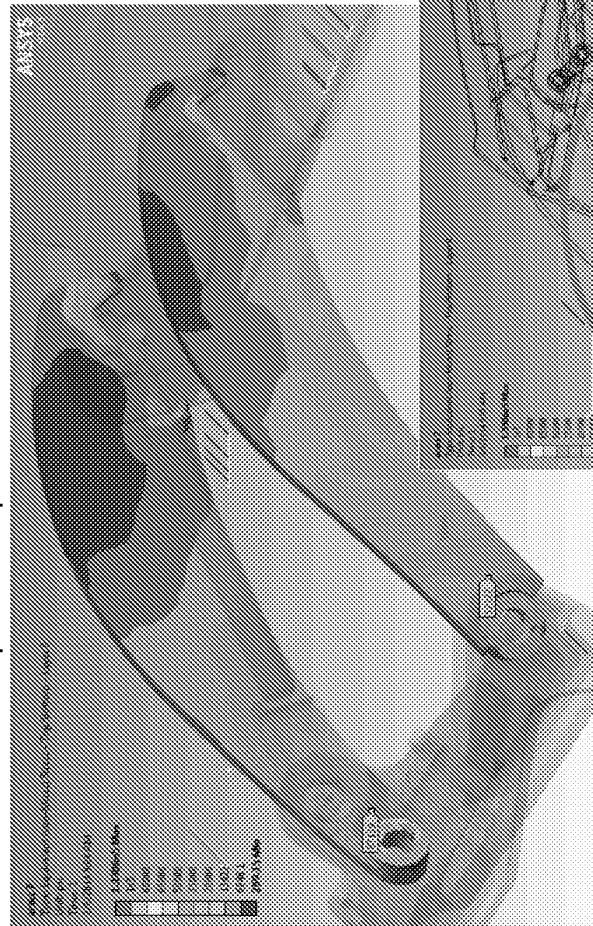
- Uses defined loads (21 cases)
- High Position - Leveler Load now originates 32" below bucket
 - And 12" forward



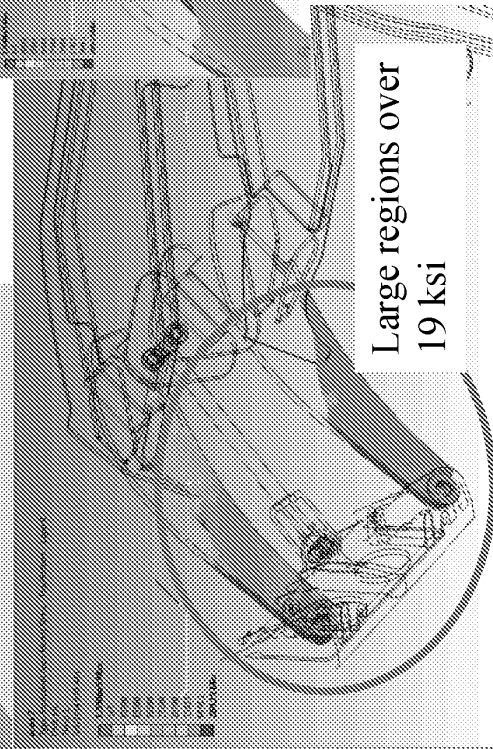


Fatigue Criteria (19 ksi?)

- Leveler, High Position
 - Force originates 32" below bucket
 - 45 Kip bucket piston force



Potential initiation sites



Large regions over 19 ksi

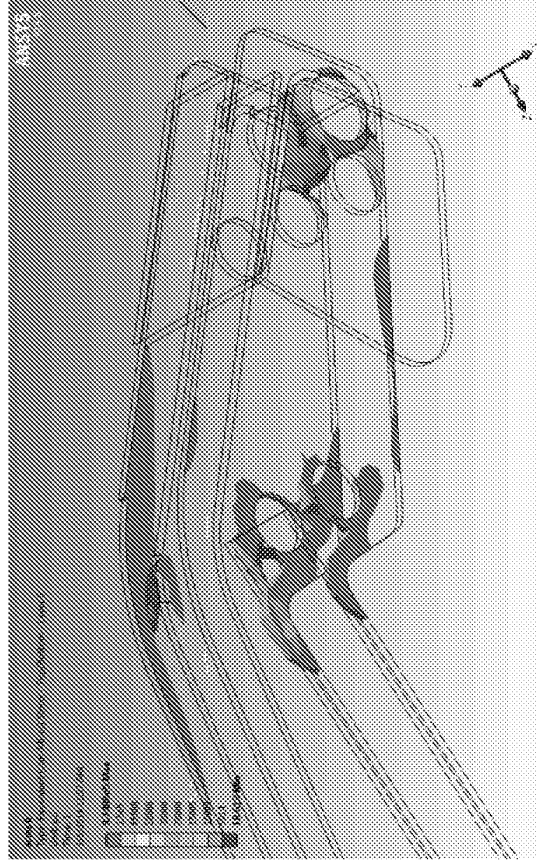
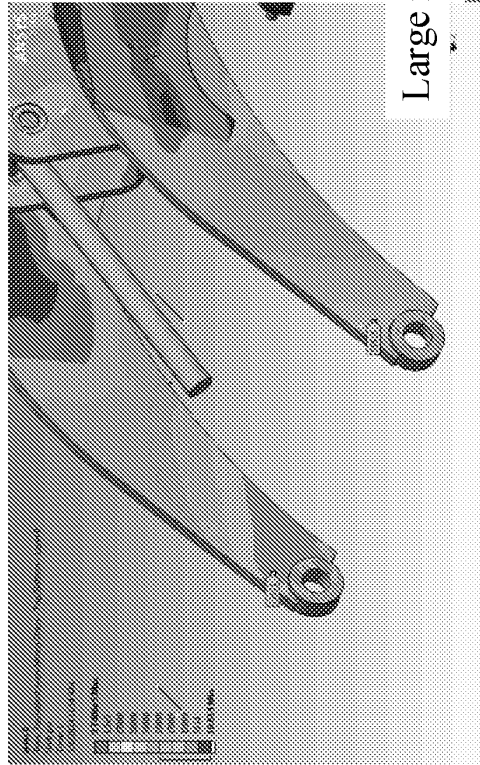




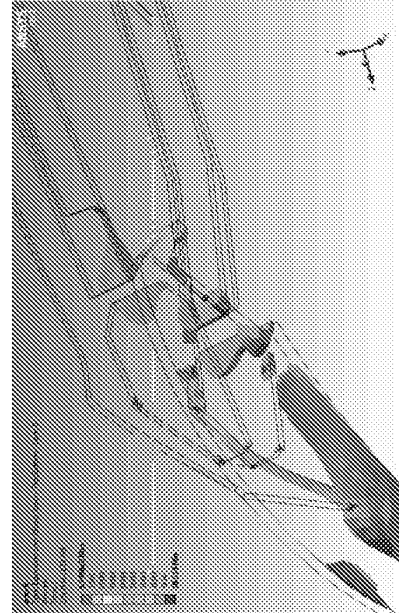
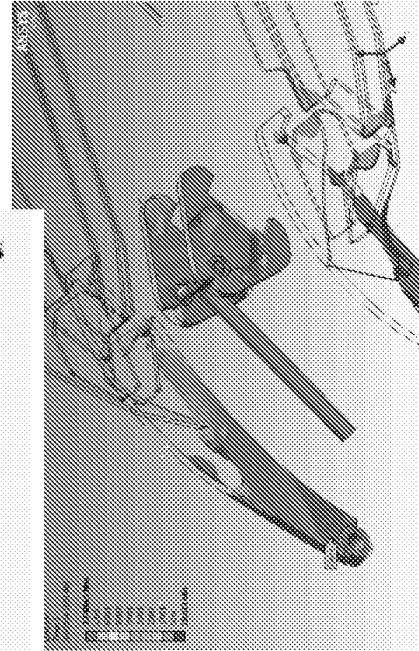
Fatigue Criteria (19 ksi?)



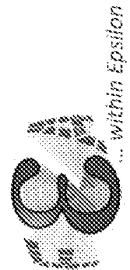
- Leveler, Med Position
 - Force originates 32" below bucket
 - 45 Kip bucket piston force



Large regions over 19 ksi



4

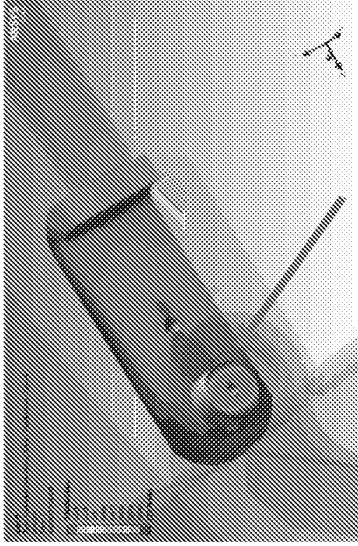
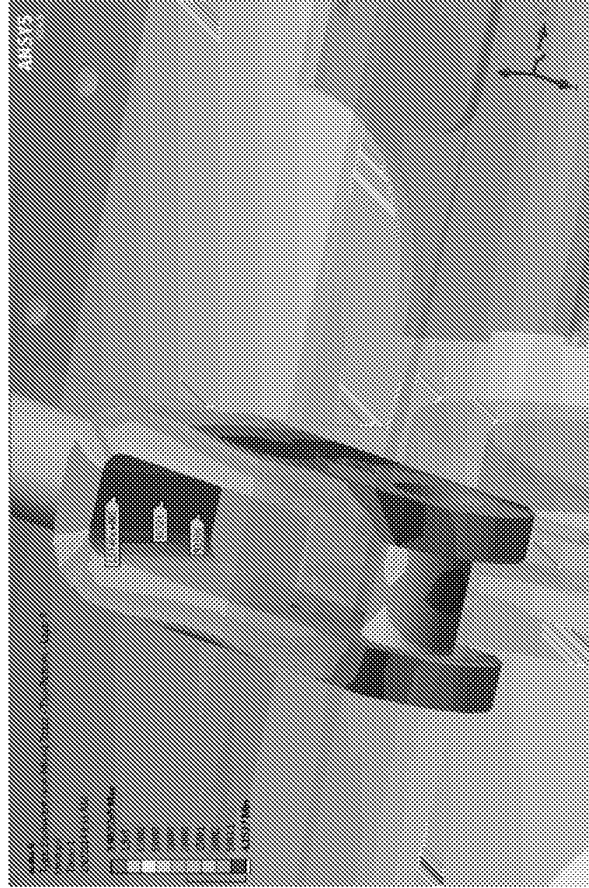




Fatigue Criteria (19 ksi?)

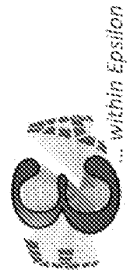
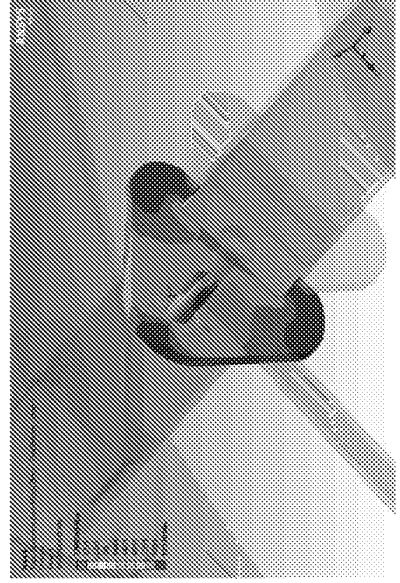


- Leveler, High Position
 - Force originates 32" below bucket
 - 45 Kip Bucket Piston Force



Pin x-sect. area = 0.78 in^2
45 kip gives 58 ksi avg. shear stress!

Pin x-sect. area = 0.59 in^2
45 kip gives 58 ksi avg. shear stress!

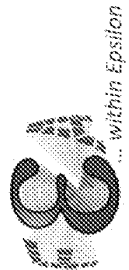
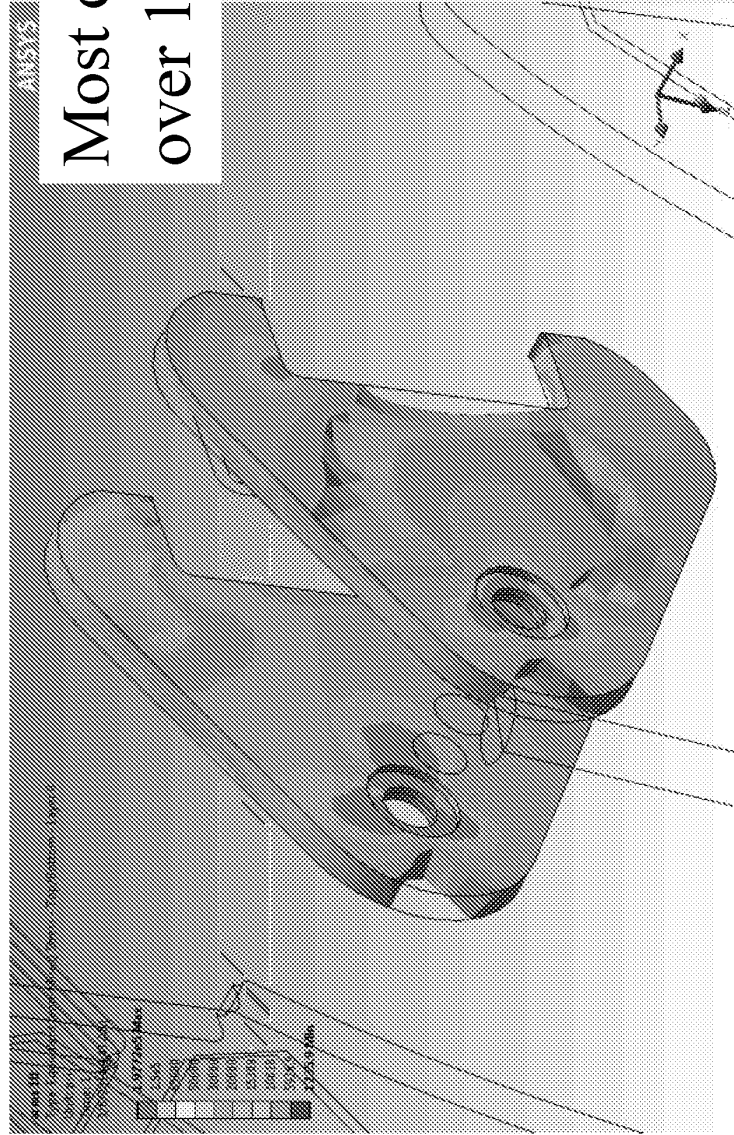




Fatigue Criteria (19 ksi?)



- Leveler, High Position
 - Force originates 32" below bucket
 - 42 Kip Bucket Piston Force

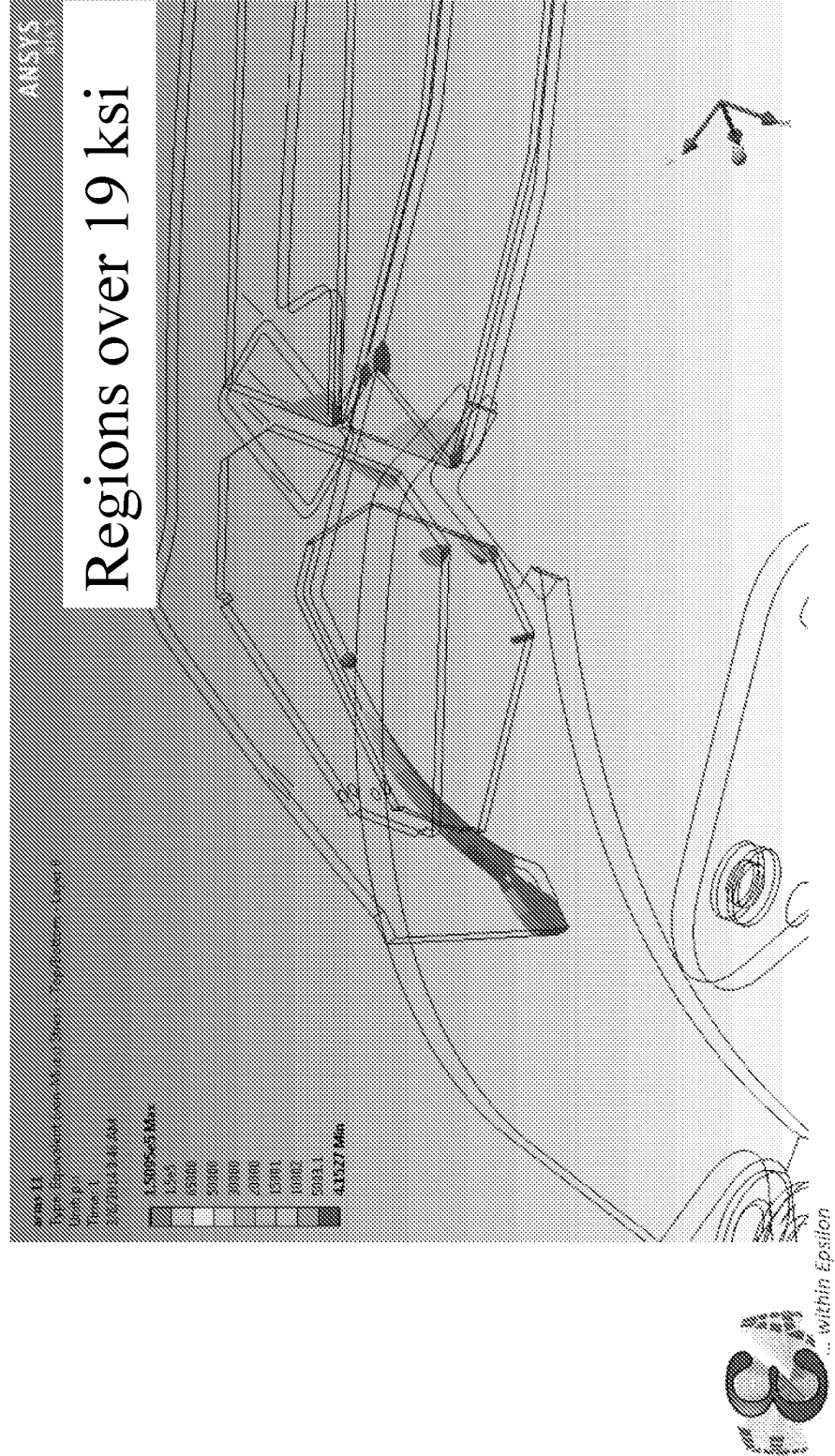




Fatigue Criteria (19 ksi?)



- Leveler, High Position
 - Force originates 32" below bucket
 - 45 Kip Bucket Piston Force



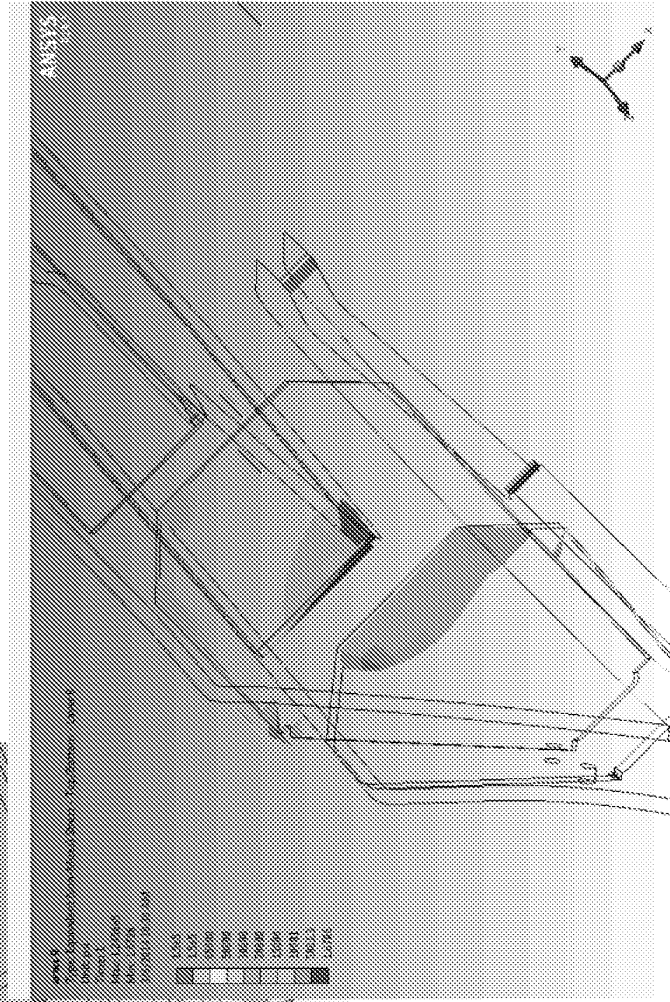
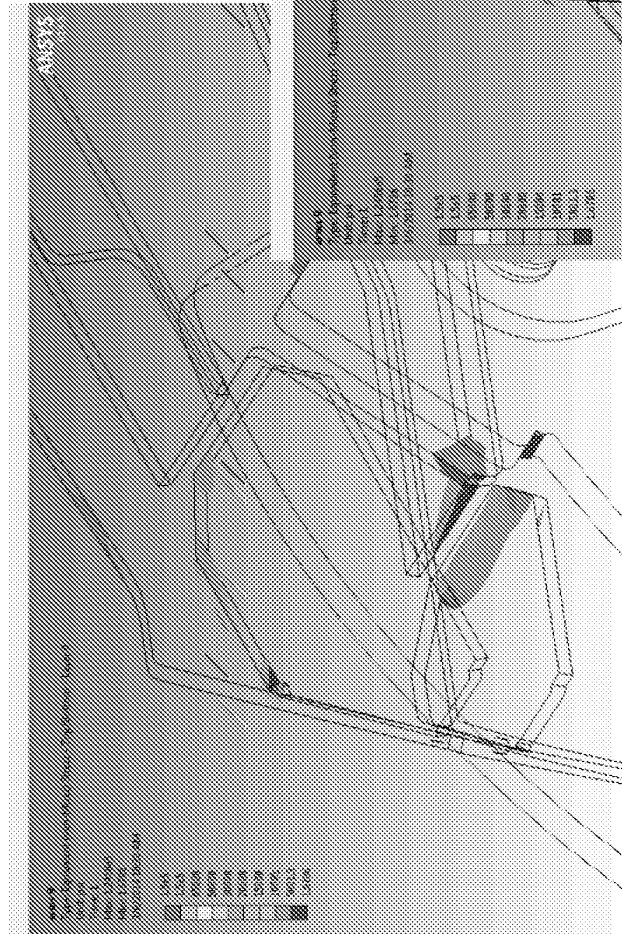


Fatigue Criteria (19 ksi?)



- Digging, Down Position

Regions over 19 ksi

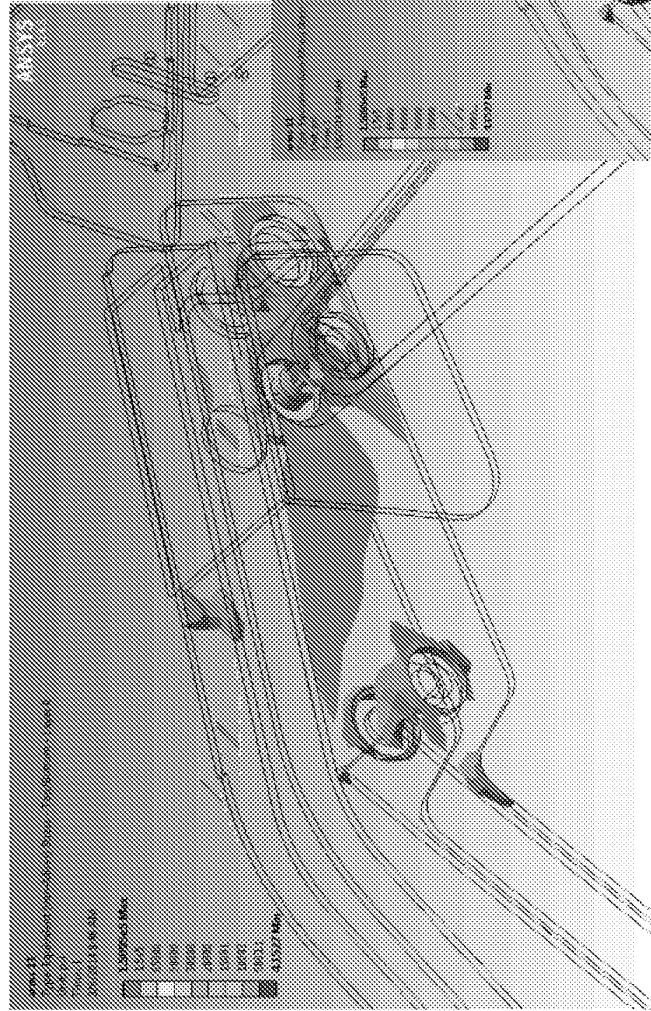




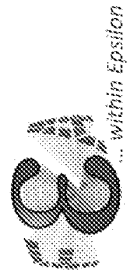
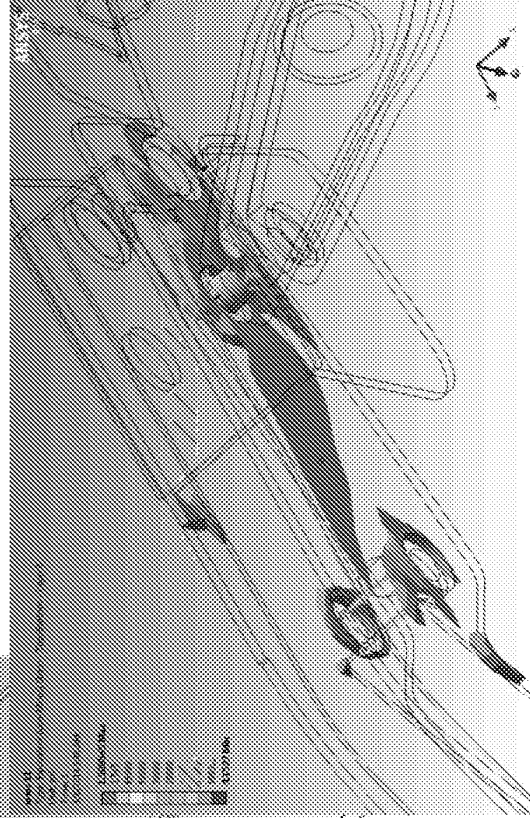
Fatigue Criteria (19 ksi?)



- Leveler, High Position
 - Force originates 32" below bucket
 - 45 Kip Bucket Piston Force



Other regions over 19 ksi

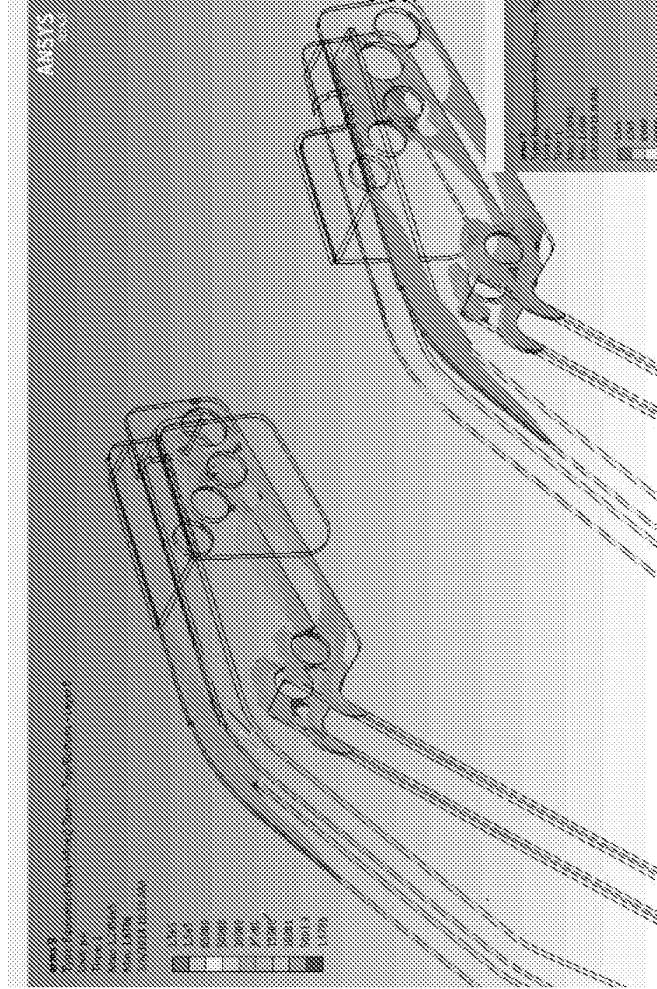




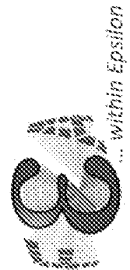
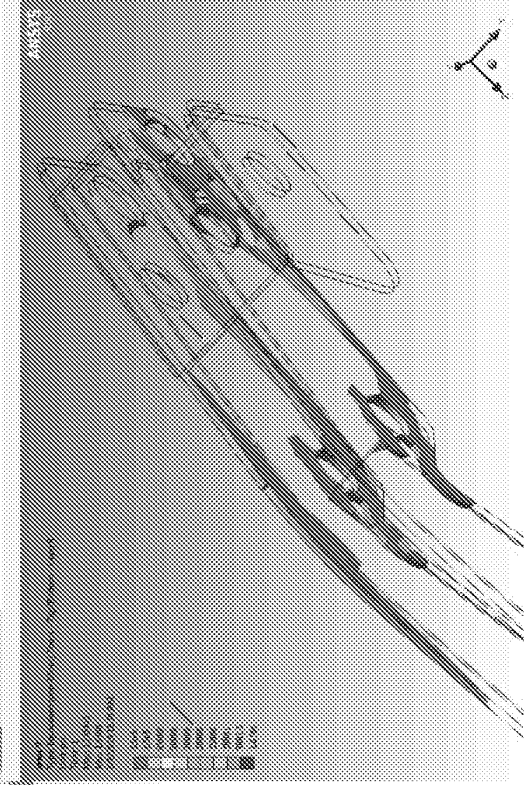
Fatigue Criteria (19 ksi?)



- Digging, Low Position



Regions over 19 ksi

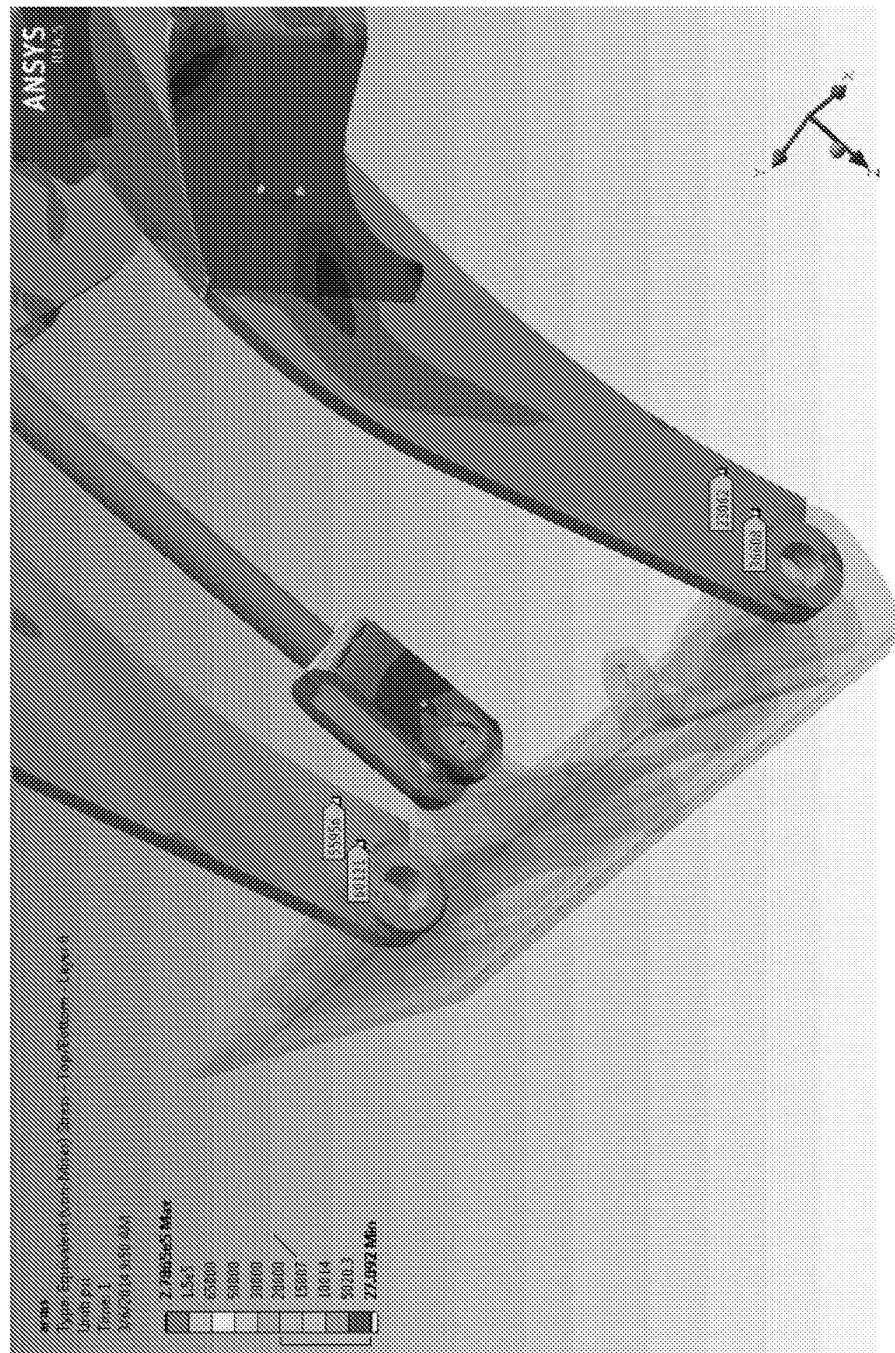




Yield Criteria (50 ksi)



- Auger Bounce, High Position
 - 27 kip bucket piston force

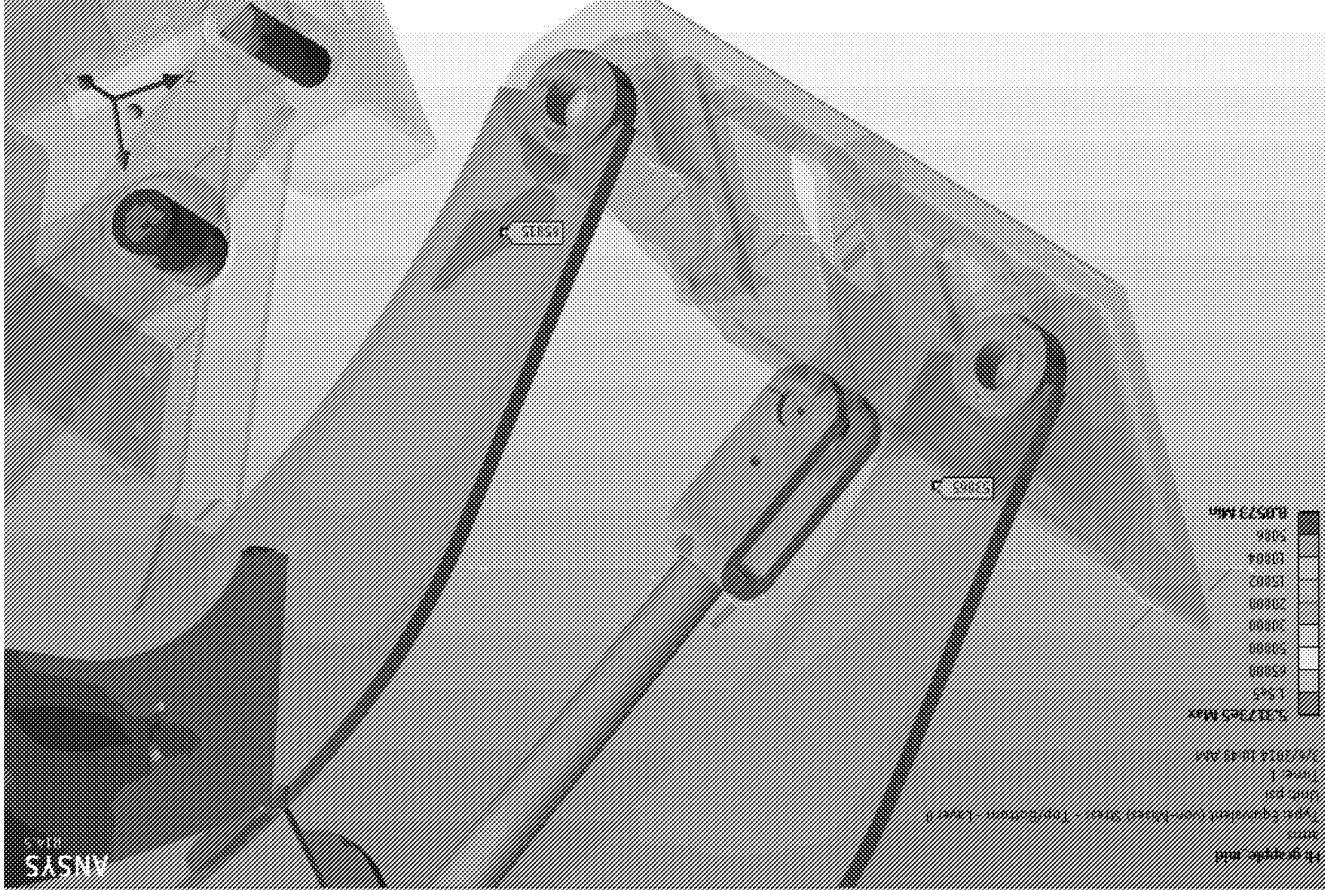




Yield Criteria (50 ksi)



- Offset Grapple, Middle Position



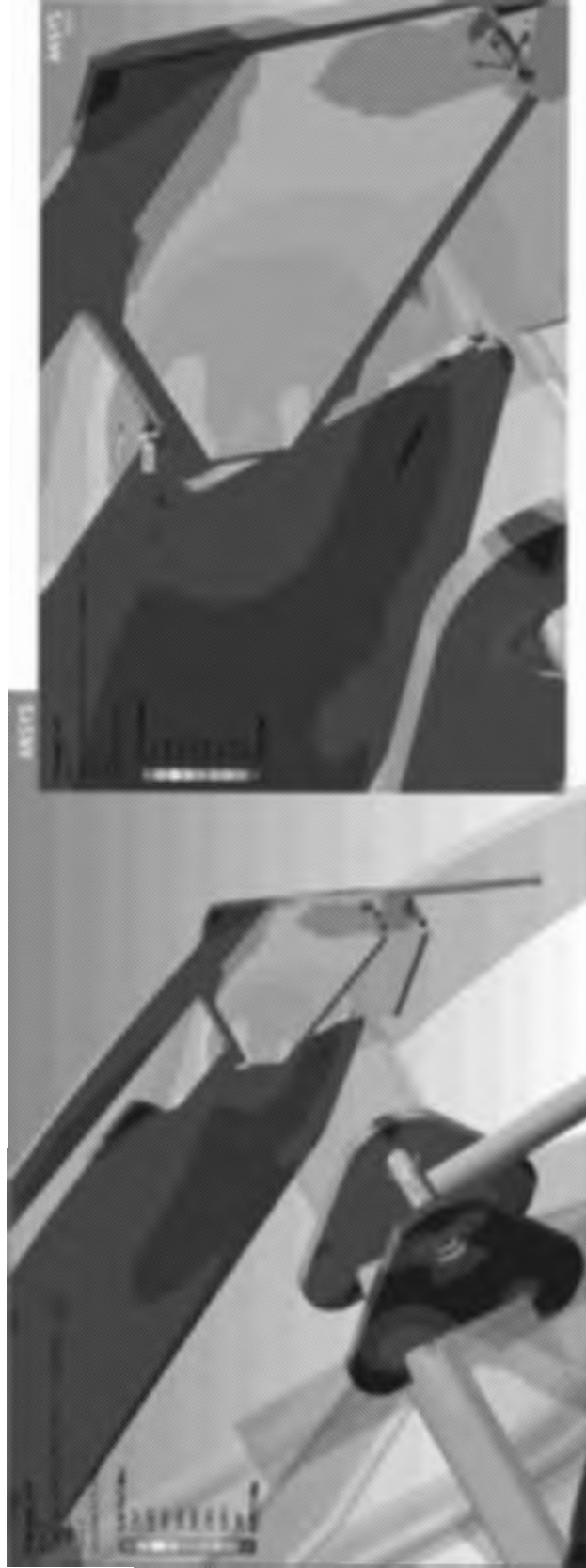
... Within Epsilon



Yield Criteria (50 ksi)



- Offset Grapple, Middle Position

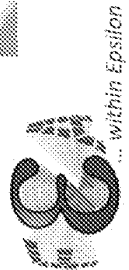


Top 85, ksi
Bottom, 21 ksi





- Offset Grapple, Middle Position

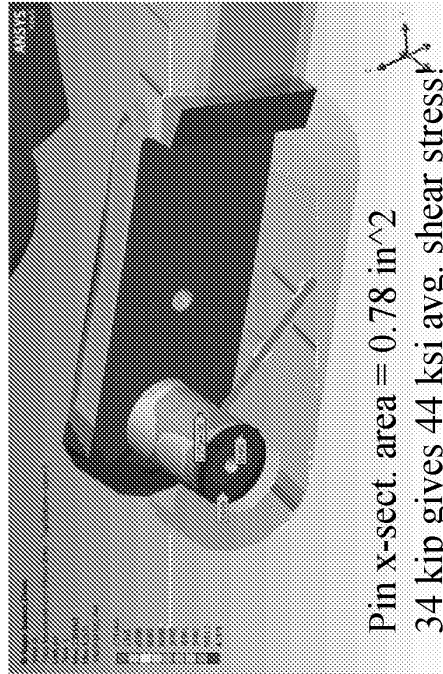
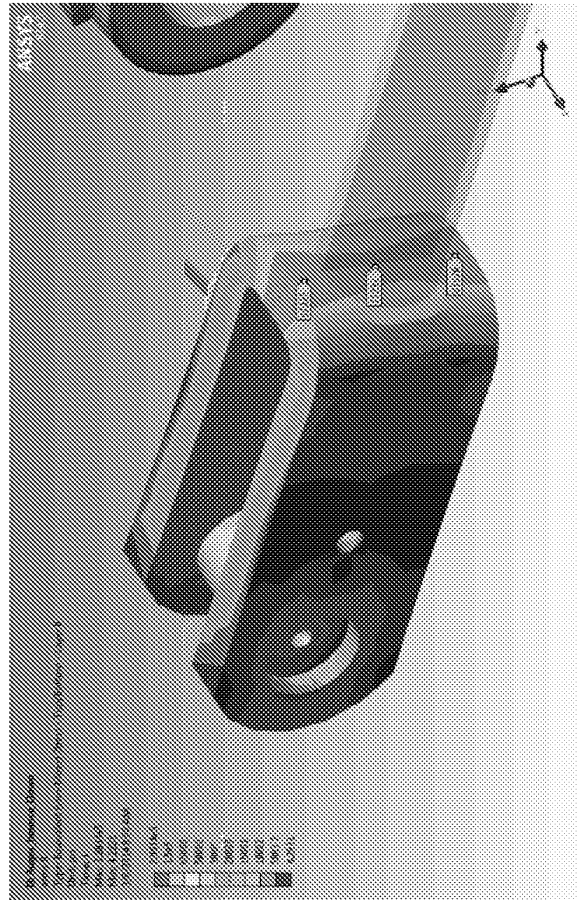




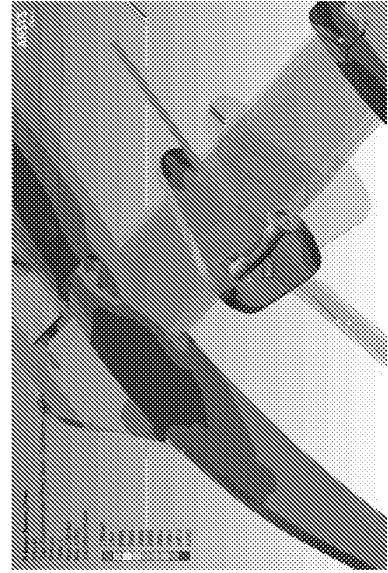
Yield Criteria (50 ksi)



- Auger Bounce, Down Position
 - 34 Kip Bucket Piston Force



Pin x-sect. area = 0.59 in^2
34 kip gives 58 ksi avg. shear stress!



15

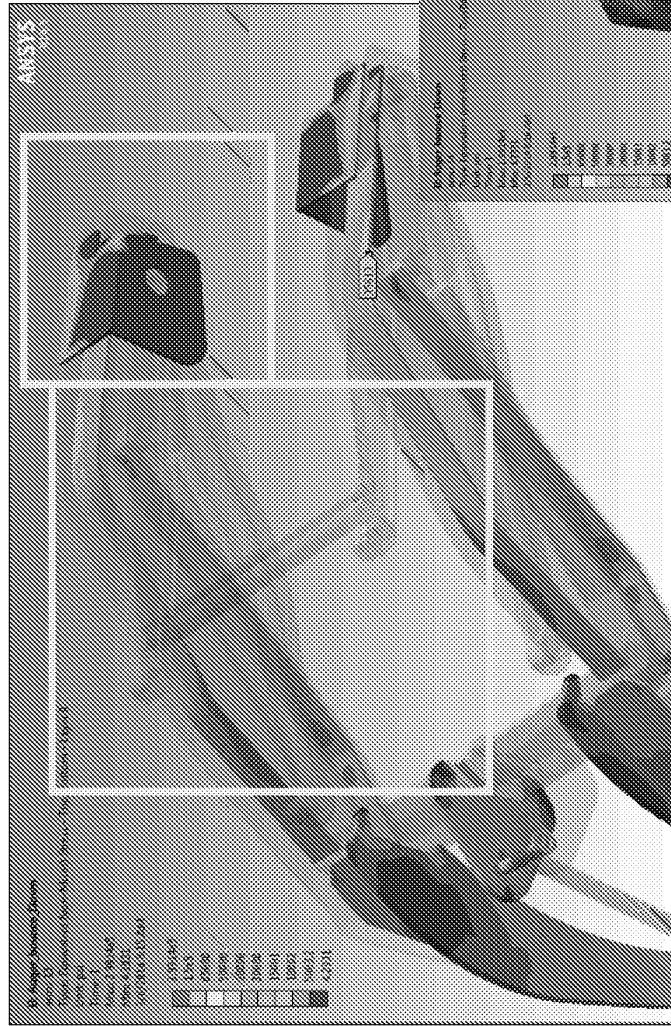




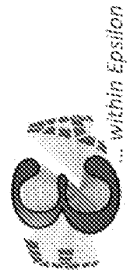
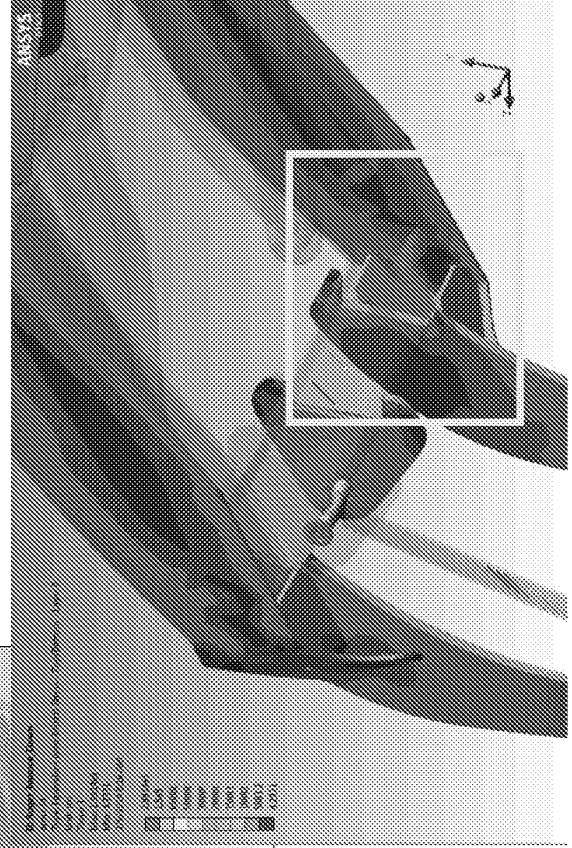
Yield Criteria (50 ksi)



- Auger Bounce, Down Position

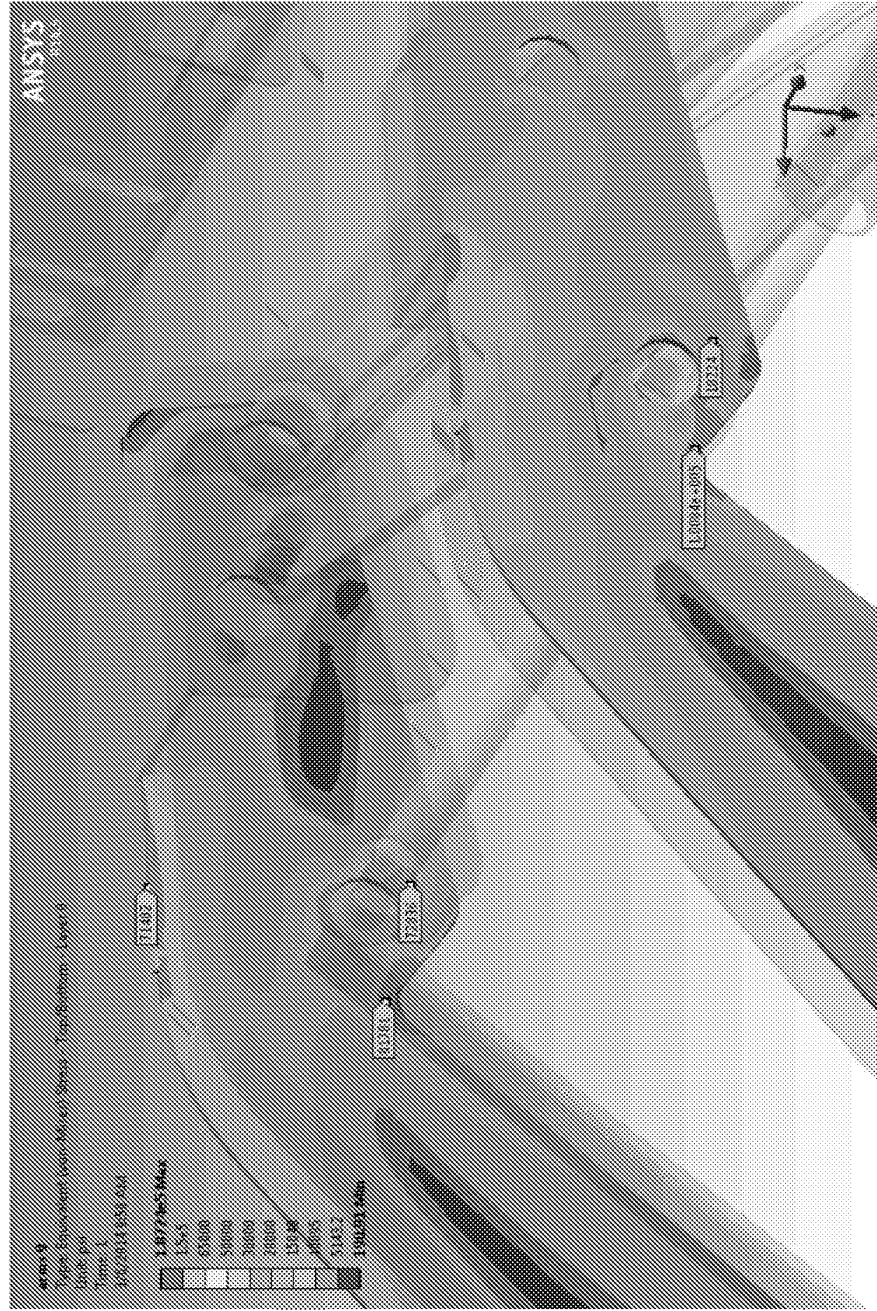


Looks good!





- Auger Bounce, high Position
 - Outboard Plates

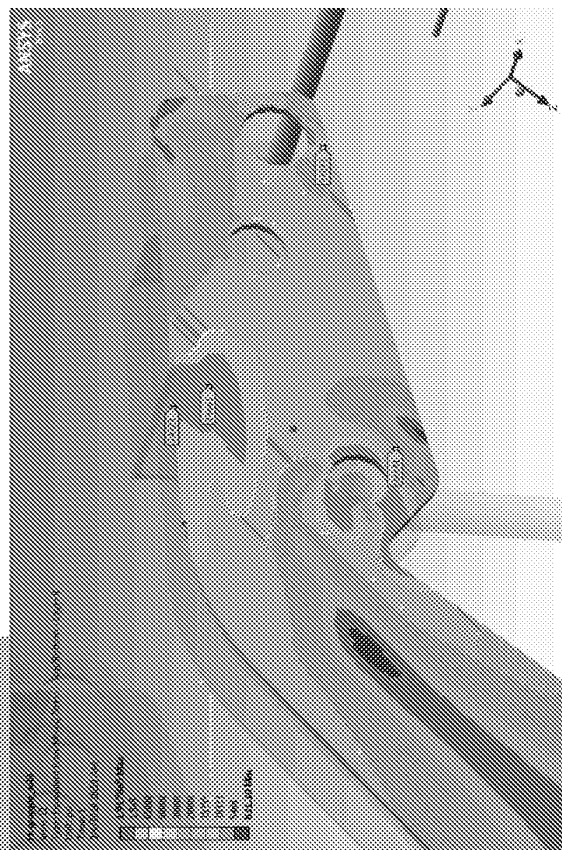
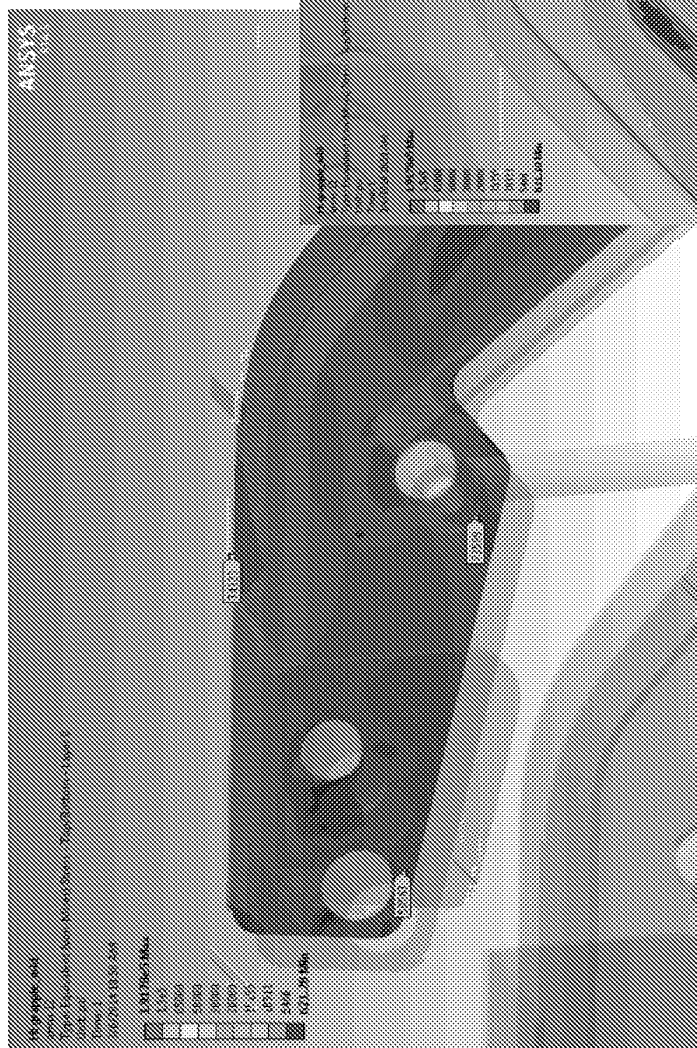




Yield Criteria (50 ksi)

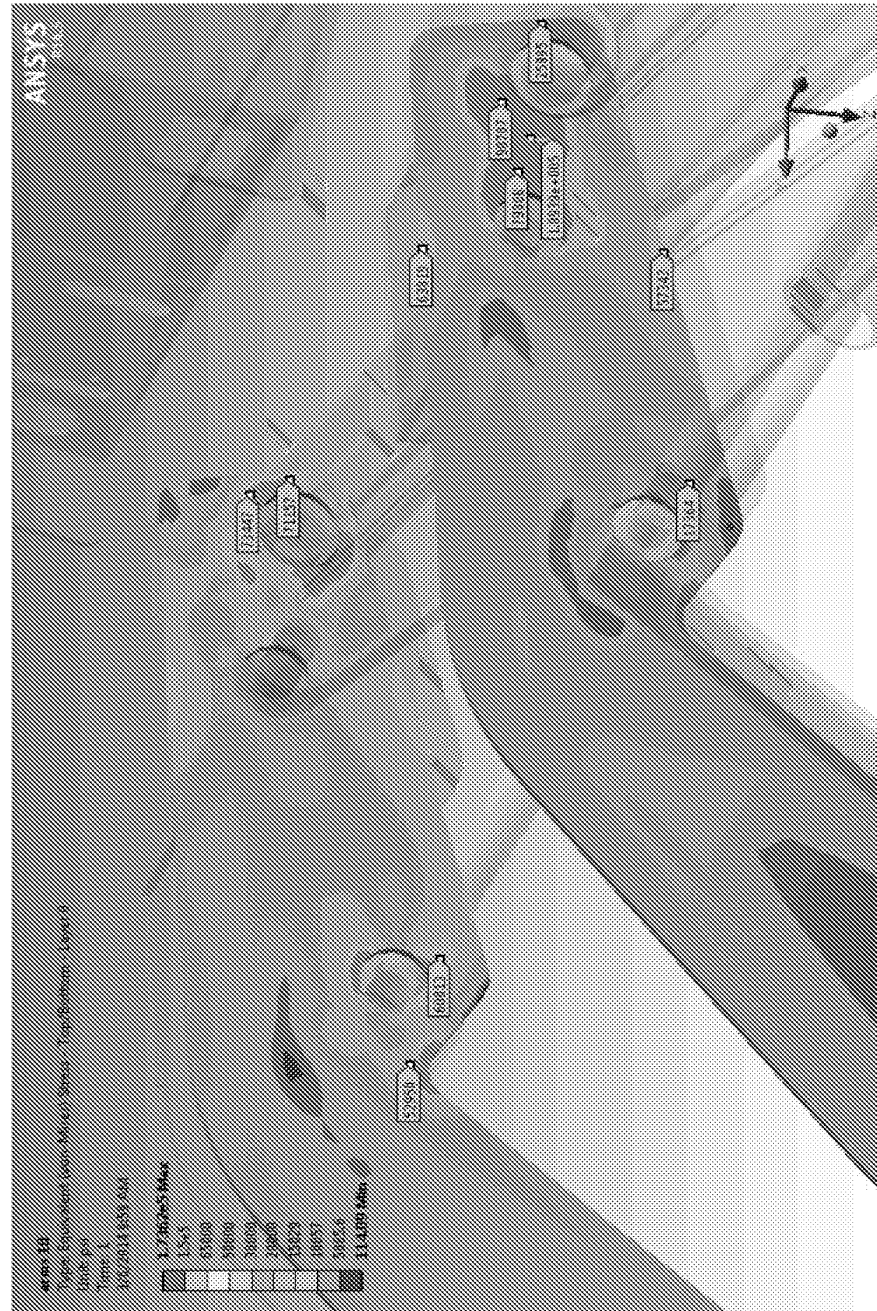


- Offset Grapple, Middle Position
 - Outboard Plates





- Auger Bounce, High Position
 - inboard Plates

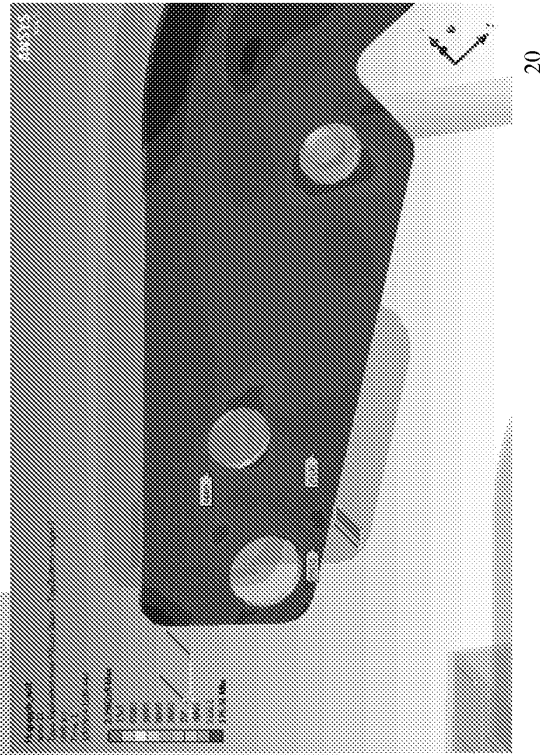
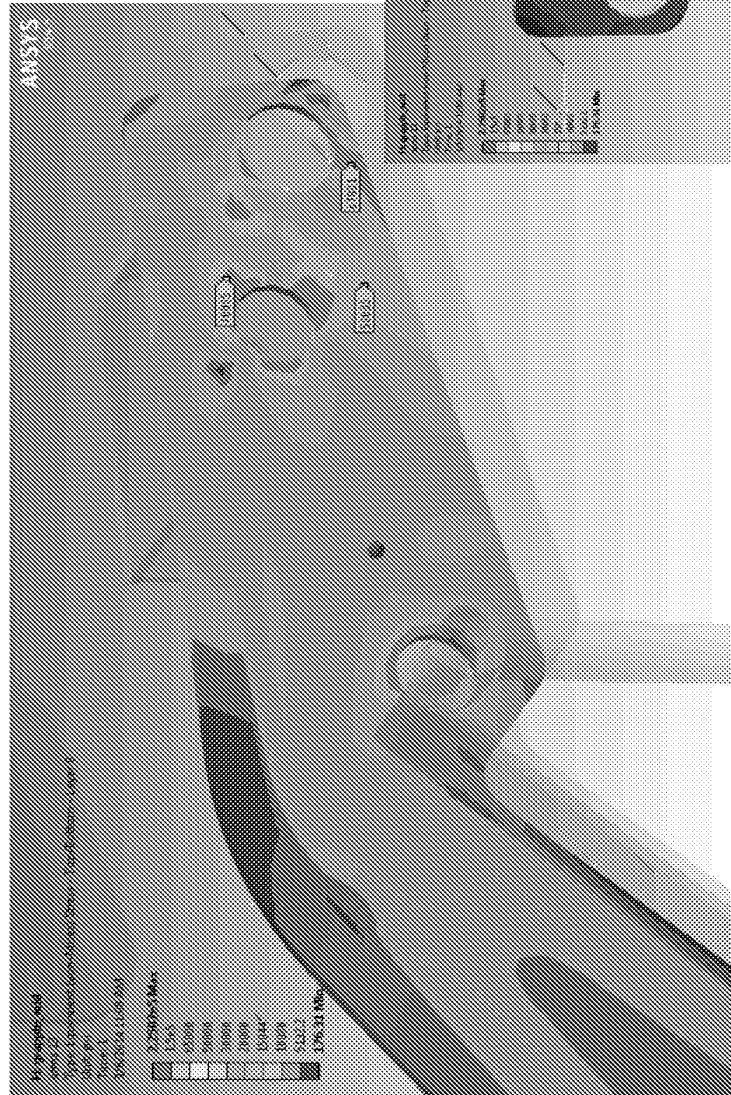


... within Epsilon



Yield Criteria (50 ksi)

- Offset Grapple, Middle Position
 - inboard Plates

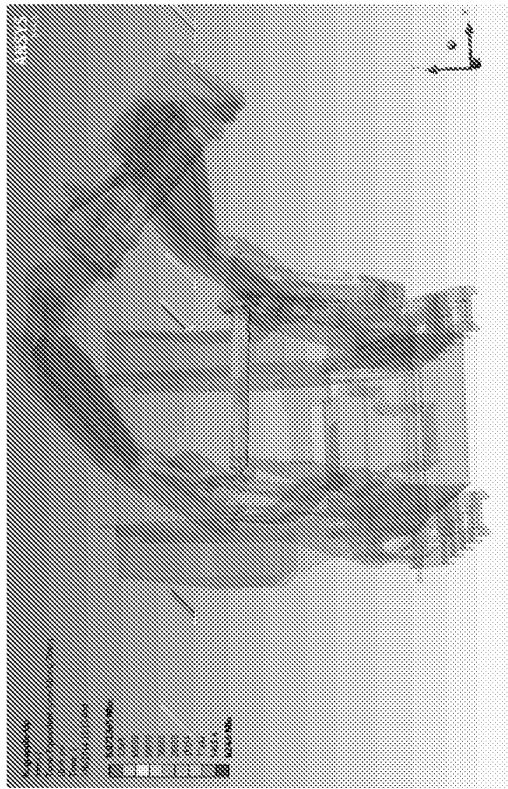
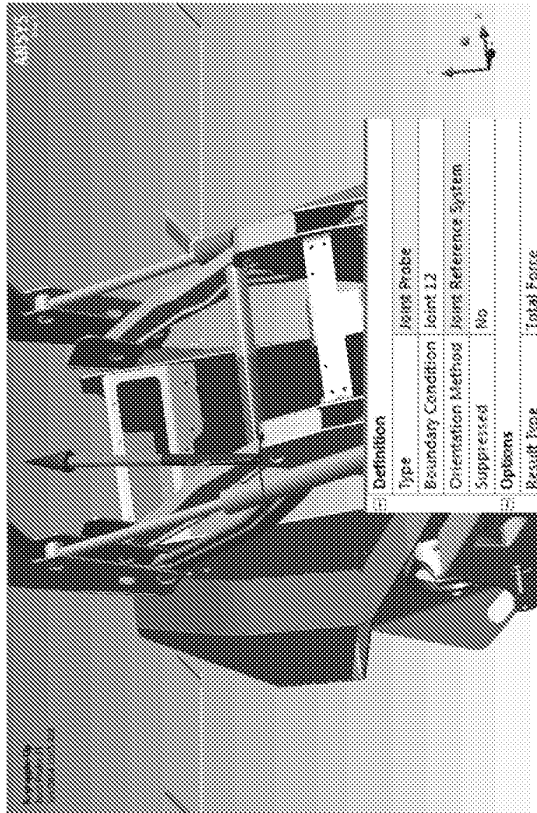




Yield Criteria (50 ksi)



- Offset Grapple, High Position
 - Crossbar
 - 5X displacement scaling
 - No bolt-pretension modeled

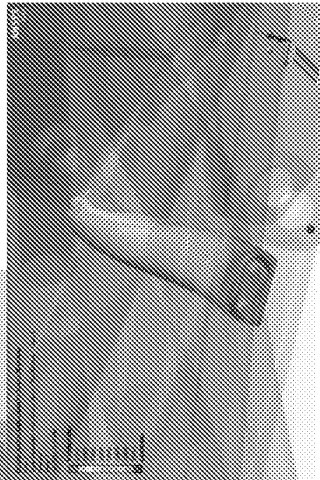
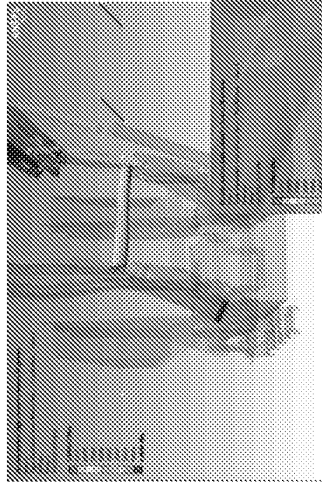
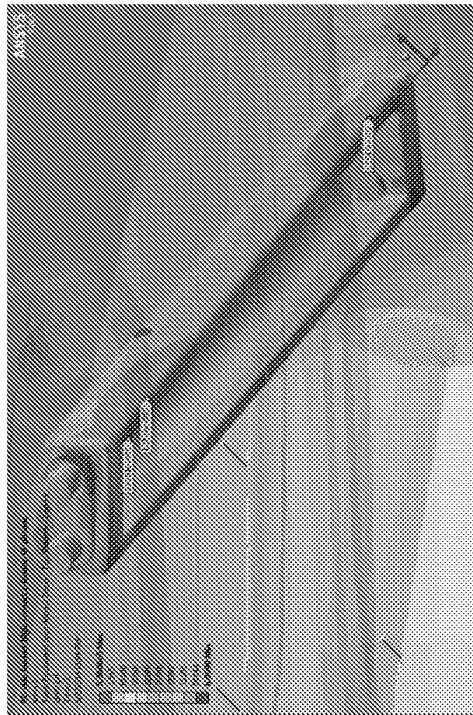




Yield Criteria (50 ksi)



- Side Impact, Bucket - High Position
 - Crossbar
 - 10X displacement scaling
 - No bolt-pretension modeled



Forces

Results

X Axis	-1407.6 lbf
Y Axis	-4075.3 lbf
Z Axis	1.9804 lbf
Total	4311.5 lbf

Moments

Results

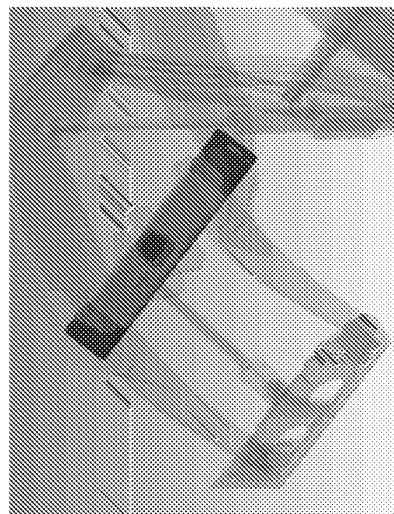
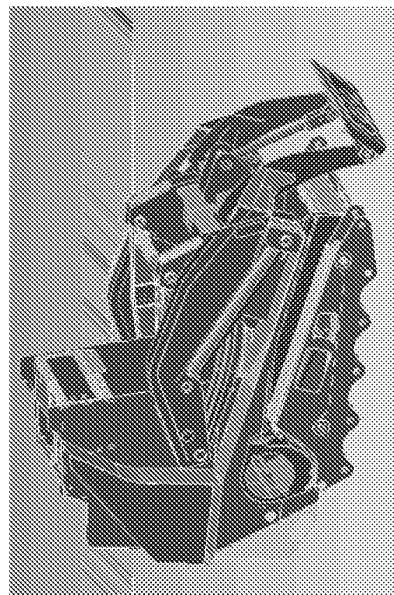
X Axis	19209 lbf-in
Y Axis	-6556.9 lbf-in
Z Axis	7072. lbf-in
Total	21494 lbf-in





TMAX Loader Cab

03/05/2014

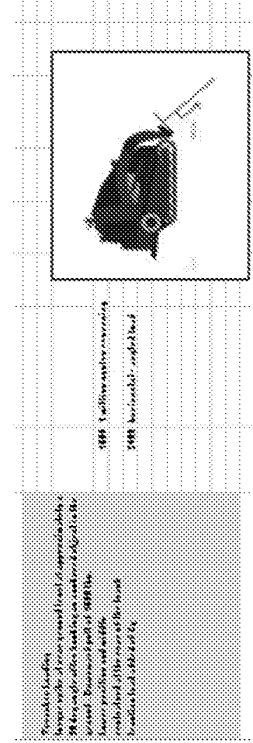
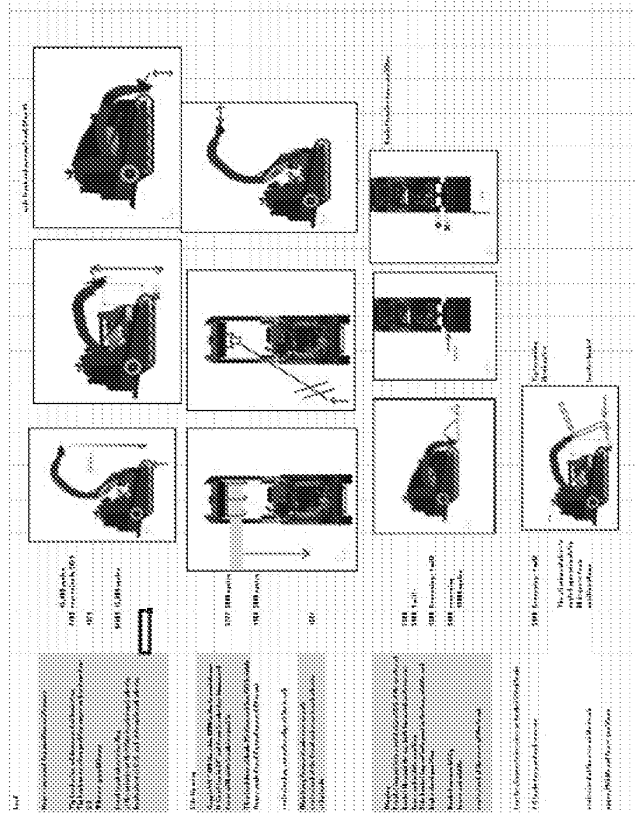




21 Load cases



- Uses defined loads (21 cases)
- High Position - Leveler Load now originates 32" below bucket
 - And 12" forward



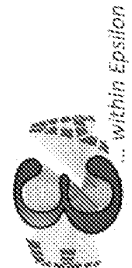


Summary



- See Excel sheets

		Peak Tower		F.S.	Cab Stress	Tracks	A
		Case Label	Stress (ksi)				
Use Cycle	Auger Bounce	High	F	171	51	51	0.98
		Med	U	122	77	41	1.22
		Low	B	172	82	39	1.28
Offset Grapple		High	K	92	97	36	0.89
		Med	H	97	110	33	1.52
		Low	Q	124	95	35	1.43
Auger Kick-out / angle		High	L	83	32	14	2.08
High Hang Fwd		High	G	42	25	13	3.25
Side Bucket Hit		High	AC	90	67	47	1.06
		Med	AD	36	29	22	2.27
		Low	AE	25	14	18	2.78
Corner Bucket Hit		Med	AB	27	46	22	2.27
		Low	AG	85	13	10	5.00
High Cycle Fatigue Cases							
Lever		High	M	51	50	50	0.35
		Med	Y	52	21	13	1.48
Trencher		Med	X	5	4	13	1.48
		Low	S	5.7	6	12	1.60
Digging		Med	V	36	42	37	0.52
		Low	C	78	26	12	1.60

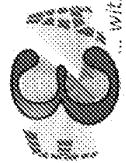
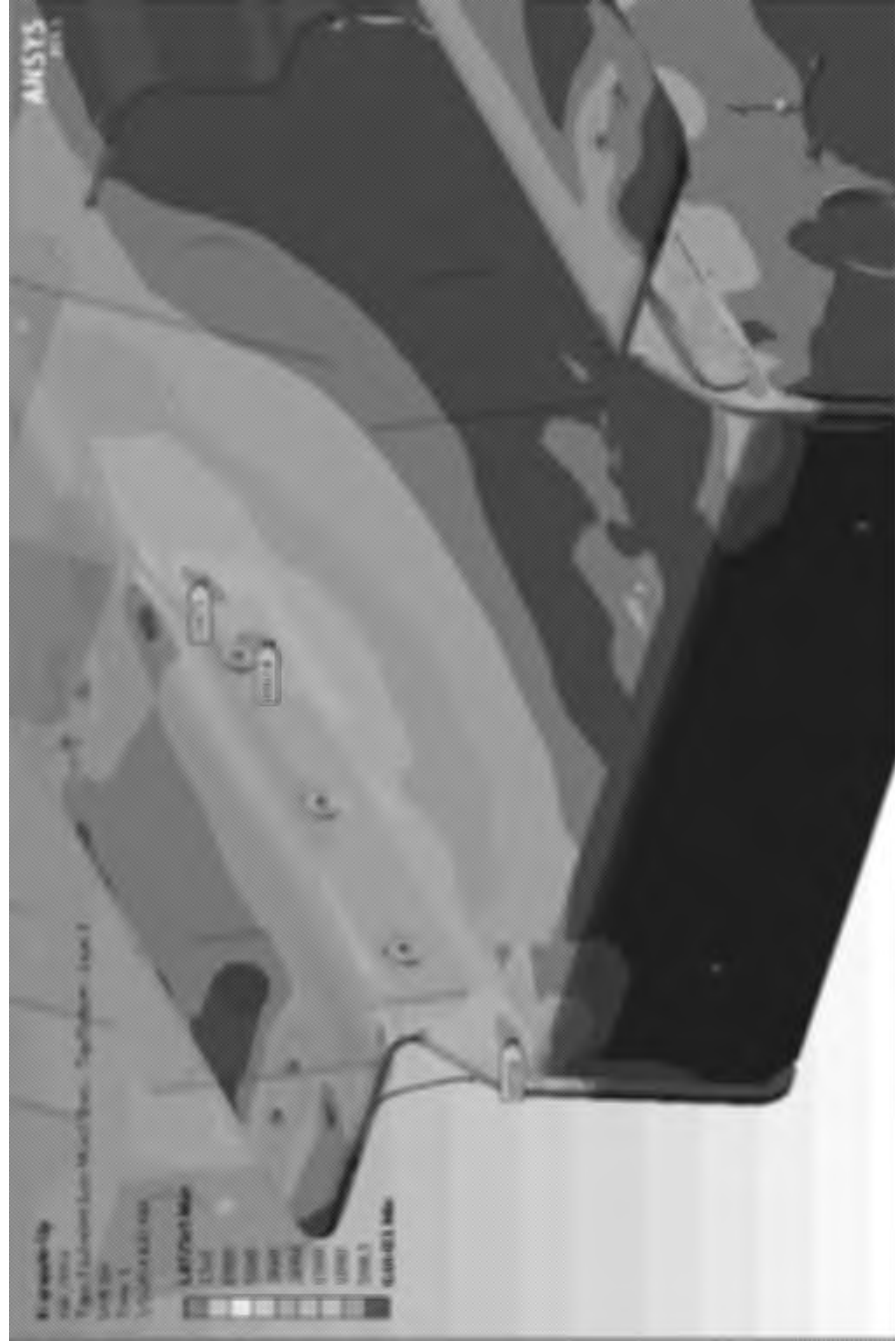




Yield Criteria (50 ksi)



- Offset Grapple, High Position

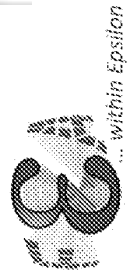




Yield Criteria (50 ksi)



- Offset Grapple, Mid Position

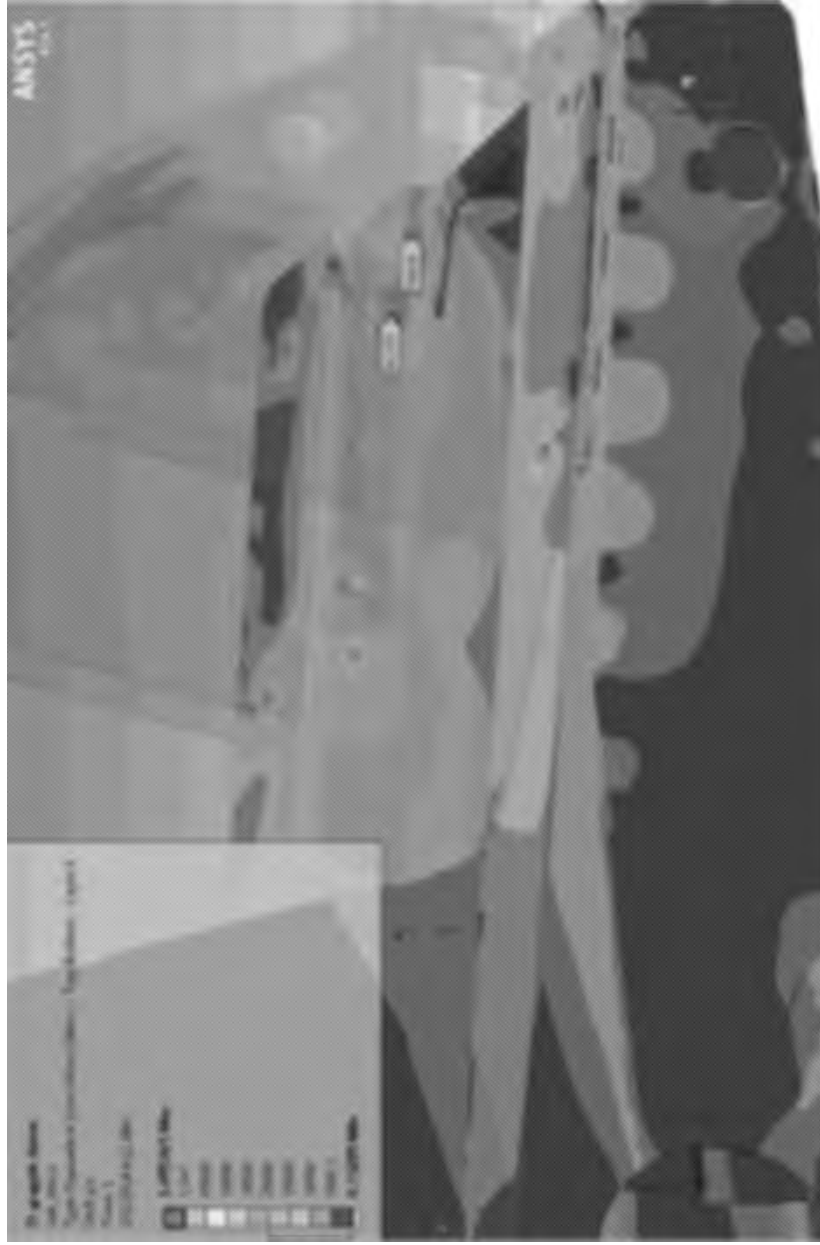




Yield Criteria (50 ksi)



- Offset Grapple, Low Position

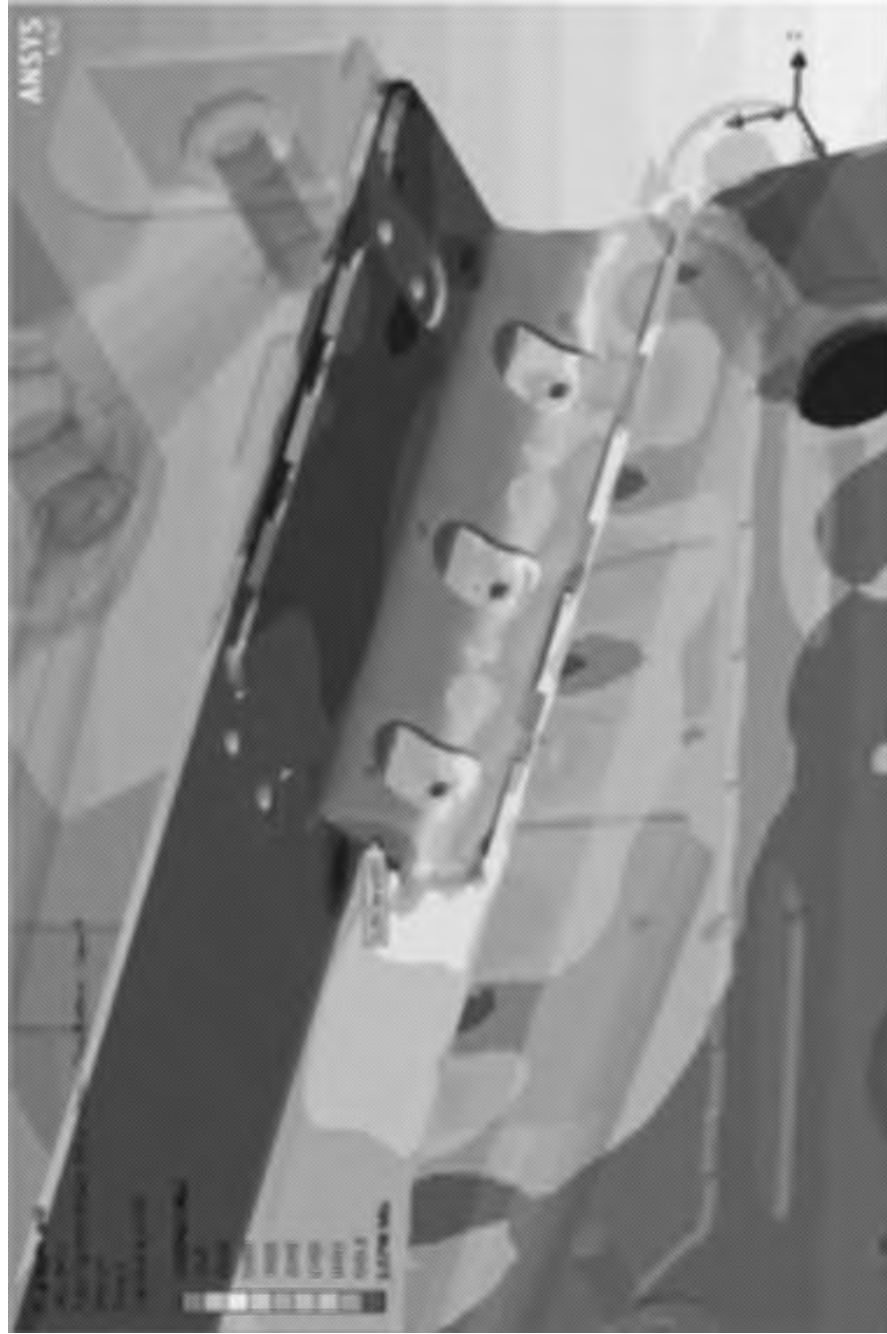




Yield Criteria (50 ksi)



- Offset Grapple, Mid Position

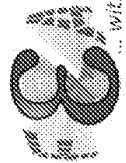




Fatigue Criteria (19 ksi?)



- Leveler, High Position is critical case



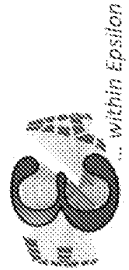
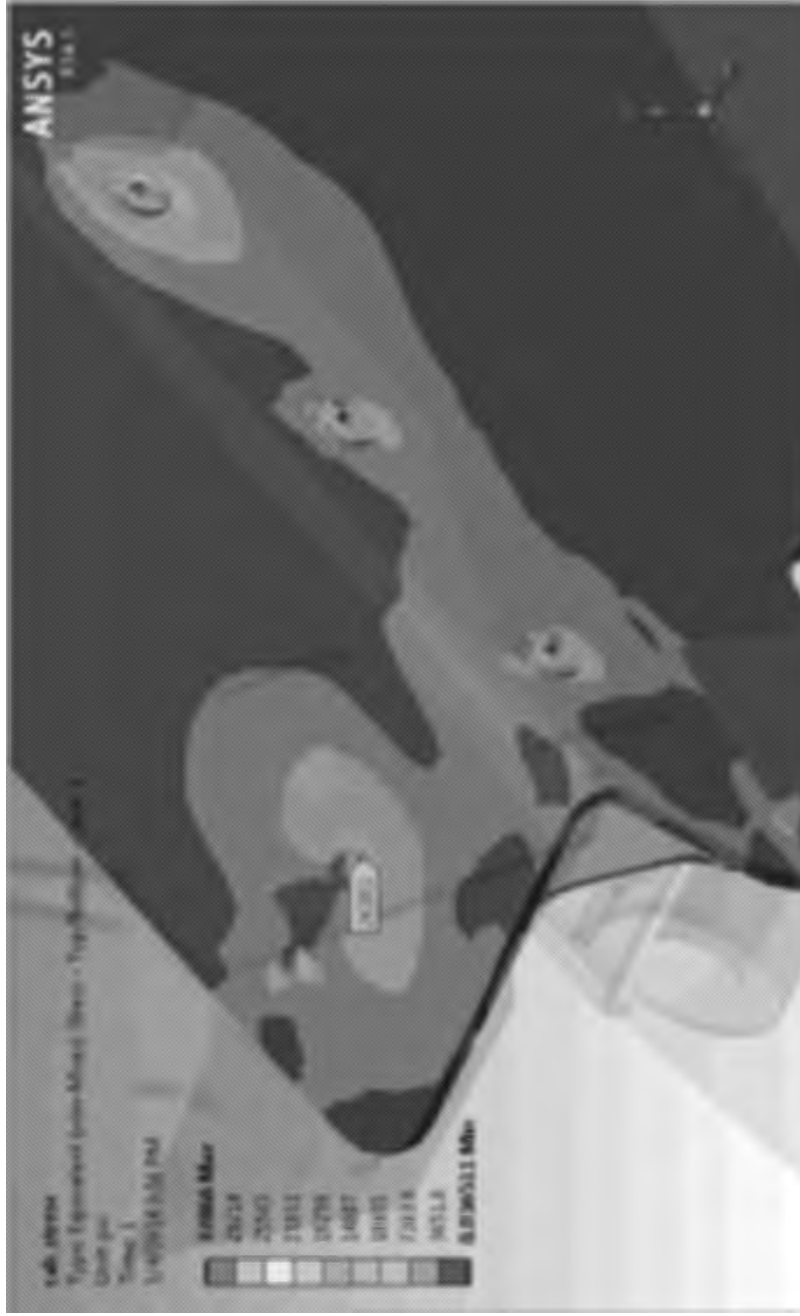
... within Epsilon



Fatigue Criteria (19 ksi?)



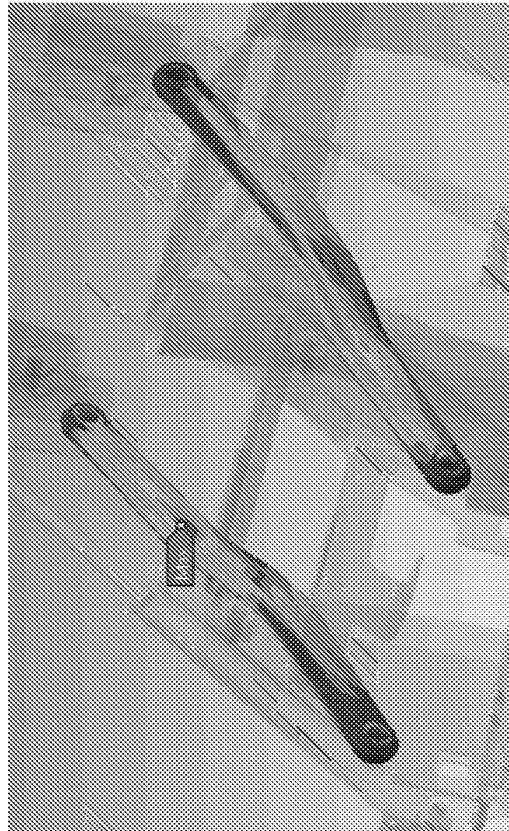
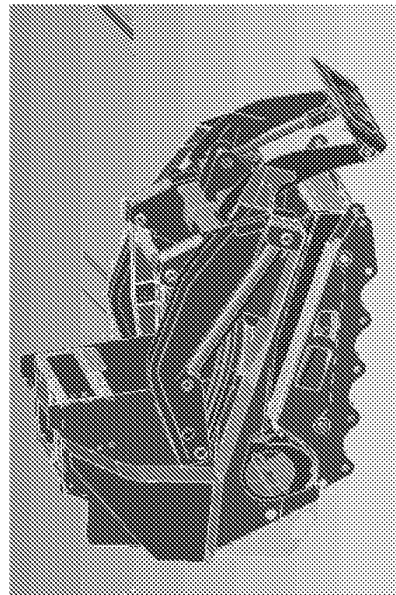
- Digging, Low is critical case





TMAX Loader Lower Arm Stresses

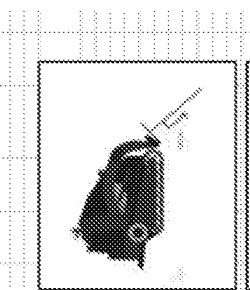
02/28/2014





21 Load cases

- Uses defined loads (21 cases)



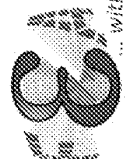


Summary



- See Excel sheets

Case Label	Peak Stress (ksi)	F S	Axial Force (lbf)	Shear Load (lbf)	Moment (ft-lbf)	Fx	Fy	Fz	Fx	Fy	Fz	Mx	My	Mz	Thrust
Auger Bounce	High	1.89	2.32	38,913	38,913	38,913	38,913	38,913	38,913	38,913	38,913	38,913	38,913	38,913	38,913
	Med	89	0.53	0	0	0	0	0	0	0	0	0	0	0	0
	Low	112	0.40	39,113	39,113	39,113	39,113	39,113	39,113	39,113	39,113	39,113	39,113	39,113	39,113
Offset Grapple	High	75.8	0.59	21,536	21,536	21,536	21,536	21,536	21,536	21,536	21,536	21,536	21,536	21,536	21,536
	Med	59.7	0.75	21,540	21,540	21,540	21,540	21,540	21,540	21,540	21,540	21,540	21,540	21,540	21,540
	Low	78.7	0.58	0	0	0	0	0	0	0	0	0	0	0	0
Auger kick-out / angle	High	38.4	1.24	0	0	0	0	0	0	0	0	0	0	0	0
	Med	43	1.03	0	0	0	0	0	0	0	0	0	0	0	0
Side Bucket Hit	High	61.5	0.73	0	0	0	0	0	0	0	0	0	0	0	0
	Med	8.5	5.29	0	0	0	0	0	0	0	0	0	0	0	0
	Low	11.1	4.05	0	0	0	0	0	0	0	0	0	0	0	0
Corner Bucket Hit	Med	9.2	4.59	0	0	0	0	0	0	0	0	0	0	0	0
	Low	45.8	0.98	0	0	0	0	0	0	0	0	0	0	0	0
Lever	High	78.9	0.22	22,546	22,546	22,546	22,546	22,546	22,546	22,546	22,546	22,546	22,546	22,546	22,546
	Med	34.4	0.48	11,404	11,404	11,404	11,404	11,404	11,404	11,404	11,404	11,404	11,404	11,404	11,404
	Low	1.5	11.33	0	0	0	0	0	0	0	0	0	0	0	0
Digging	Med	4.6	0.70	0	0	0	0	0	0	0	0	0	0	0	0
	Low	51.4	0.39	28,950	28,950	28,950	28,950	28,950	28,950	28,950	28,950	28,950	28,950	28,950	28,950

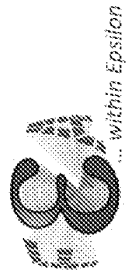
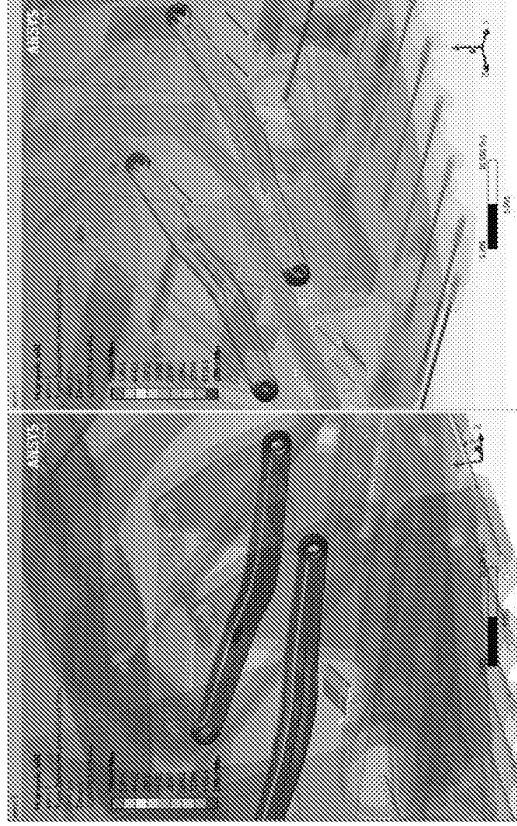
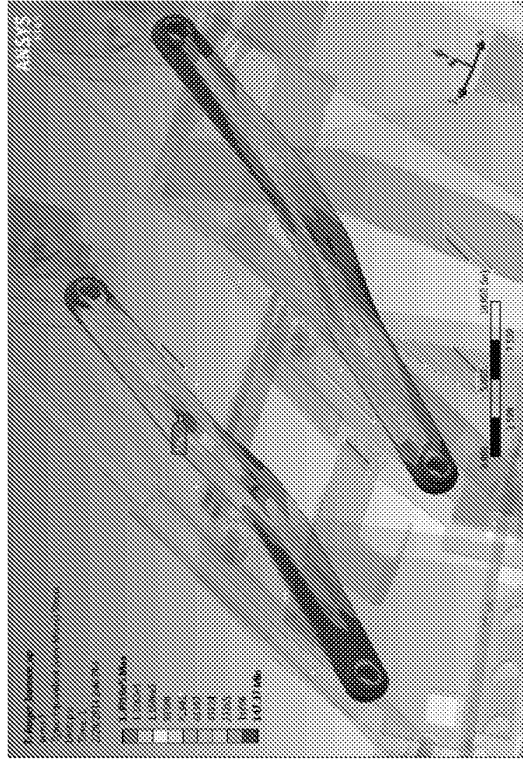


... within Epsilon



Yield Criteria (45 ksi)

- Auger Bounce, High is critical case
 - 149 ksi equivalent stress
 - 40 kip axial force
 - 4 kip shear force
 - 3900 in-lb longitudinal moment
- Offset Grapple Middle has highest moment (bending), 2900 in-lb

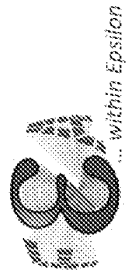
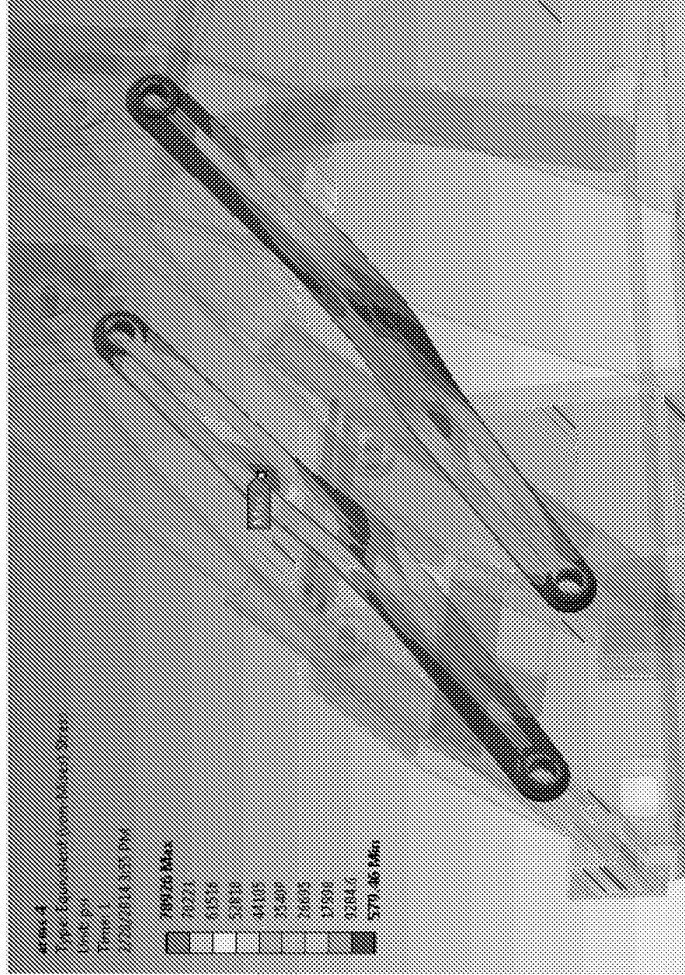




Fatigue Criteria (17 ksi?)



- Leveler, High is critical case
 - 79 ksi equivalent stress
 - 14 kip axial force
 - 2.4 kip shear force
 - 1300 in-lb longitudinal moment
 - 2270 in-lb bending moment

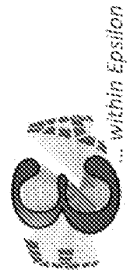
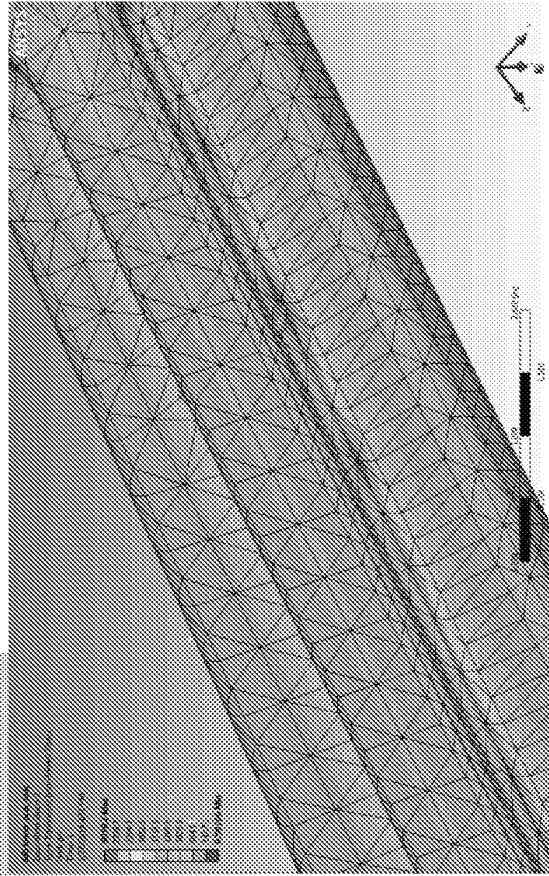
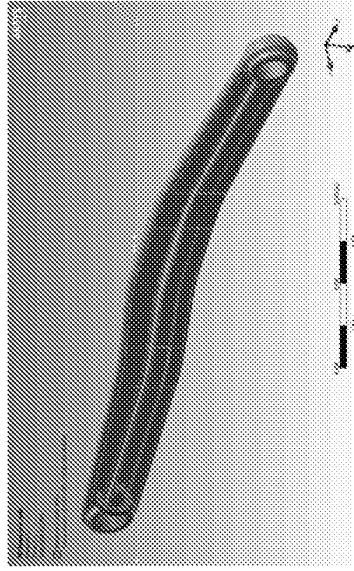
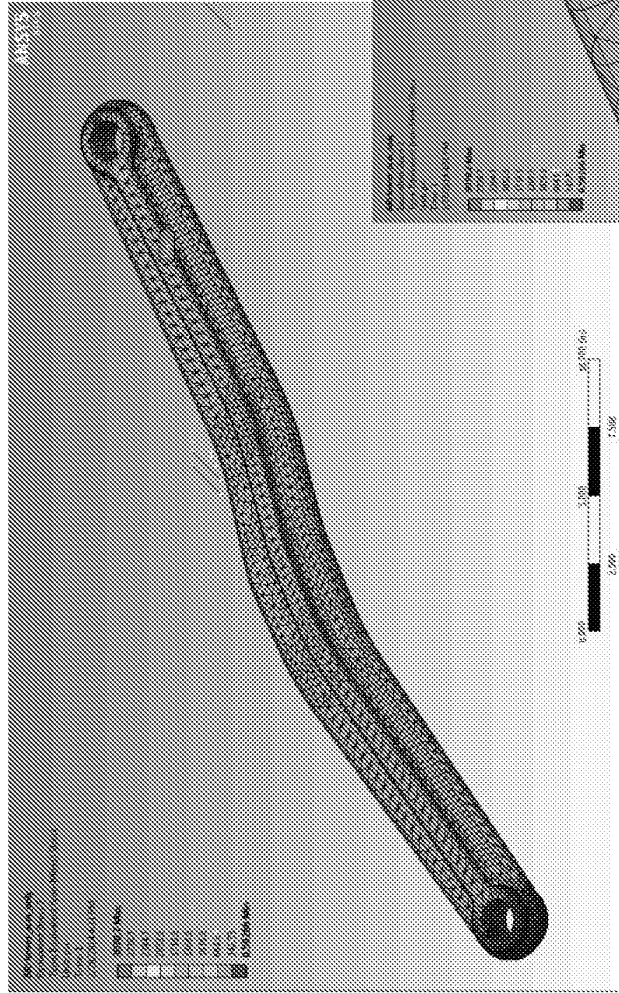




Baseline Stresses



- 1000 in-lb longitudinal moment

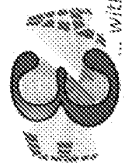
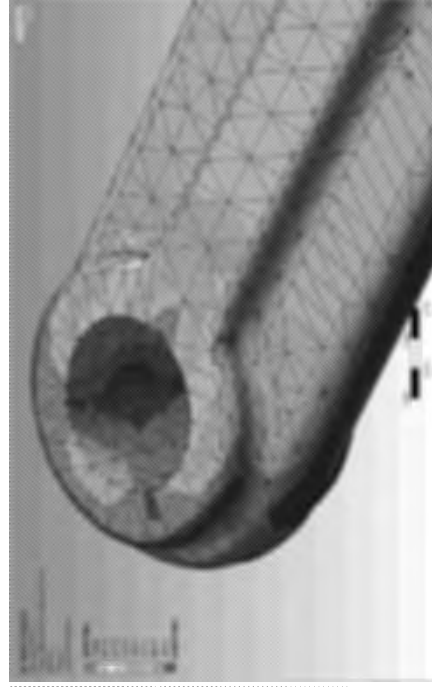
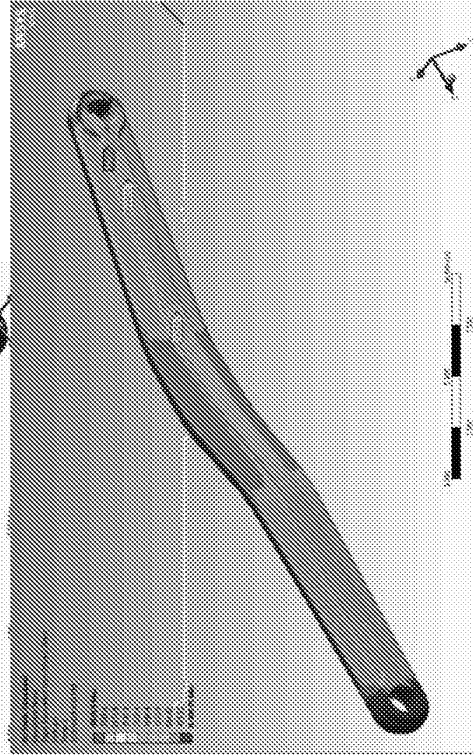
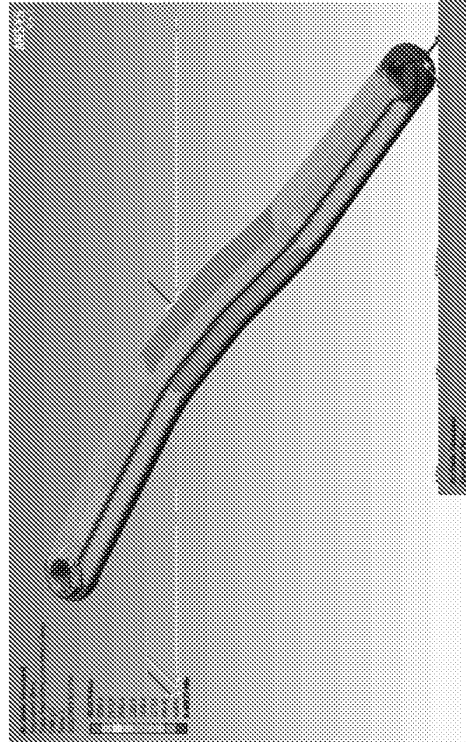
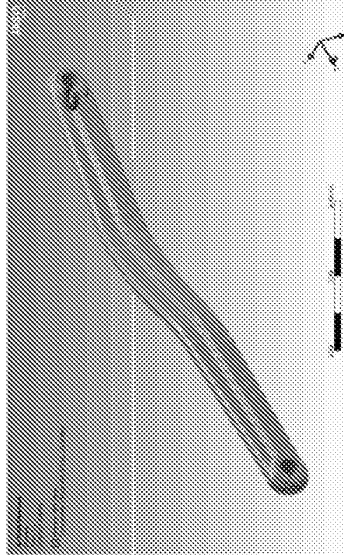




Baseline Stresses



- 1000 in-lb bending moment

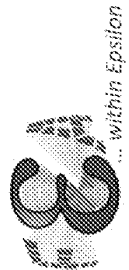
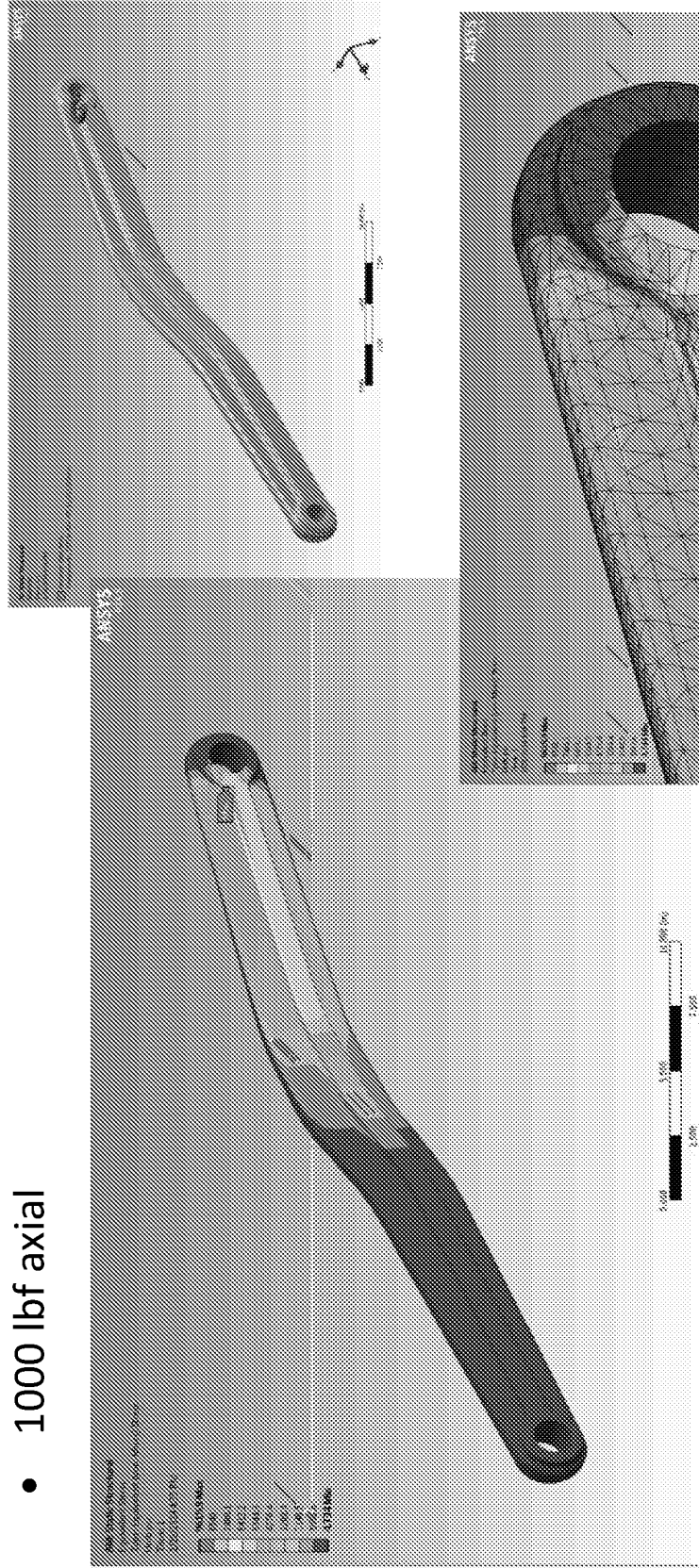




Baseline Stresses



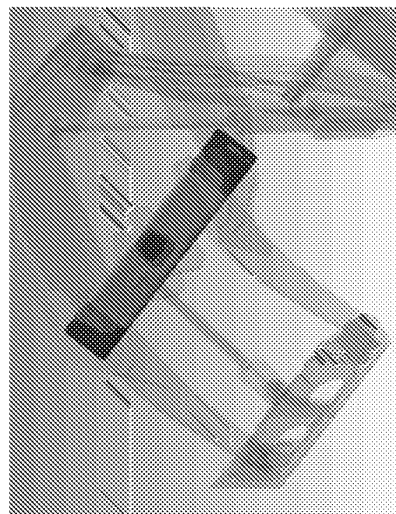
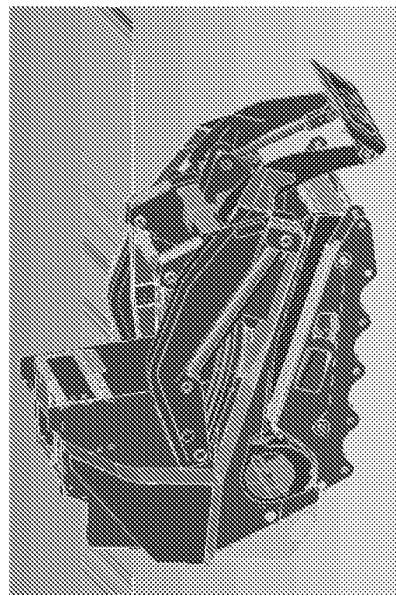
- 1000 lbf axial





TMAX Loader Tower

03/04/2014

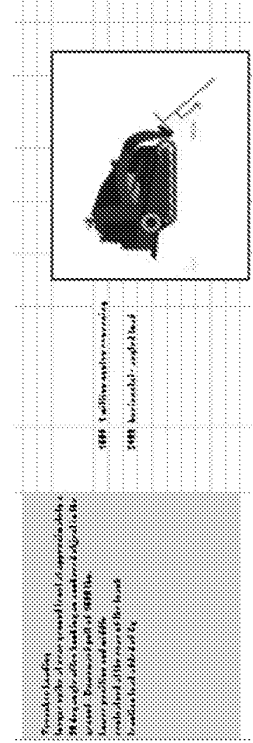
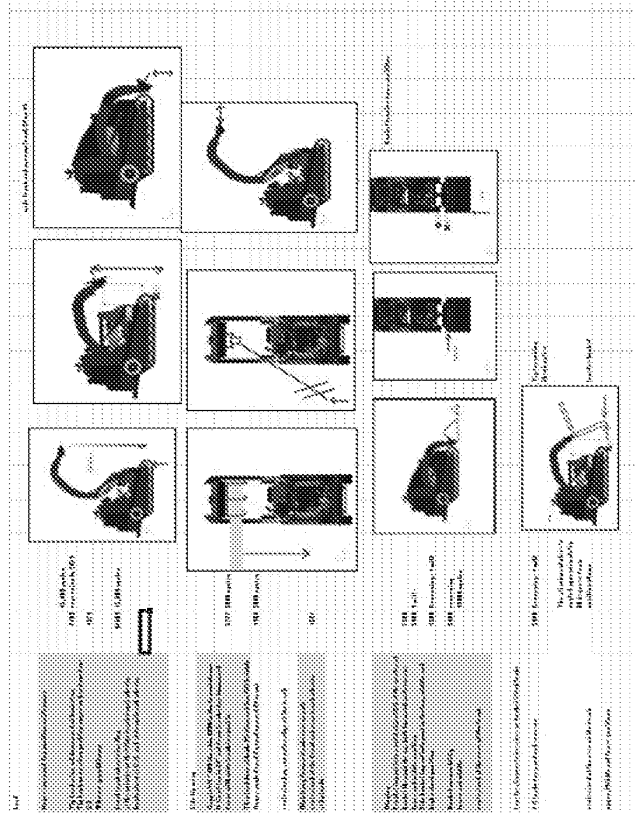




21 Load cases



- Uses defined loads (21 cases)
- High Position - Leveler Load now originates 32" below bucket
 - And 12" forward





Summary



- See Excel sheets

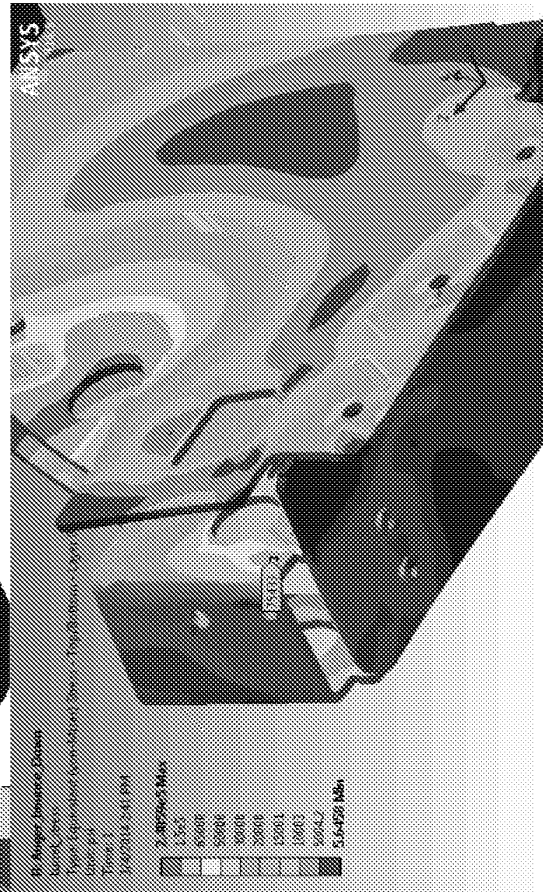
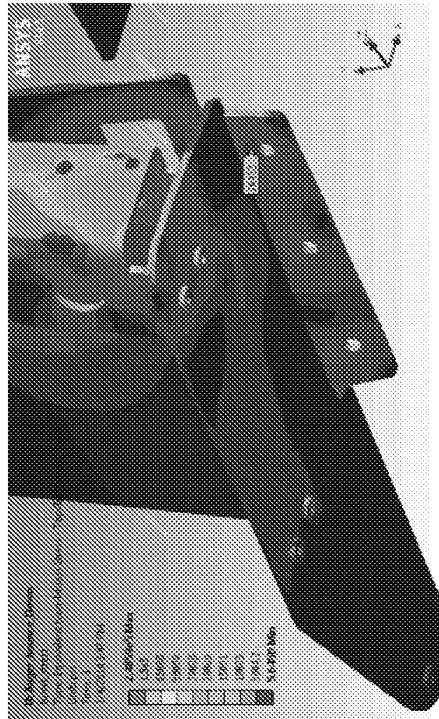
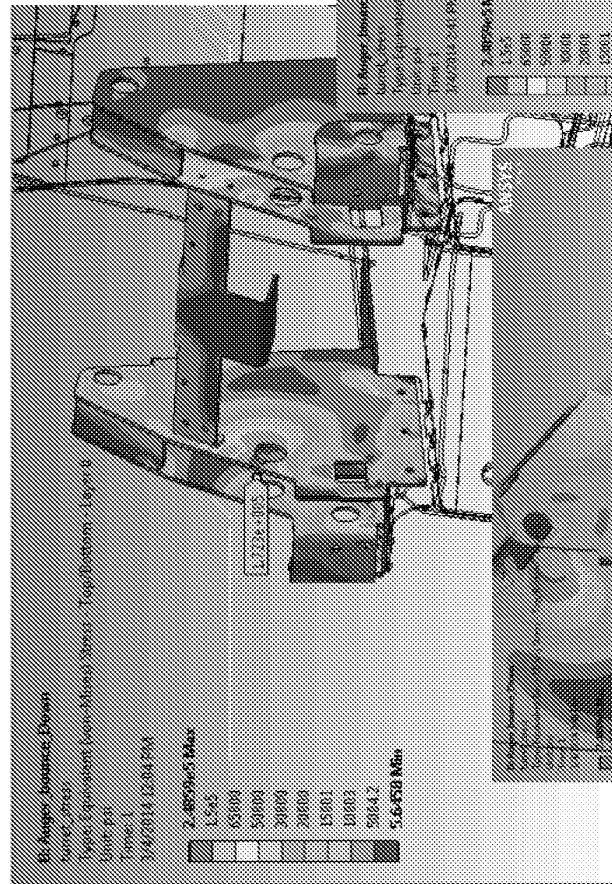
		Case Label	Peak Stress (ksi)	F.S.	A)
Low Cycle Auger Bounce					
	High	F	171	0.29	
	Med	U	123	0.41	
	Low	B	172	0.29	
Offset Grapple					
	High	K	92	0.54	
	Med	H	97	0.52	
	Low	D	124	0.40	
Auger kick-out / angle					
	High	L	63	0.79	
High Hang Fwd					
	High	G	42	1.19	
Side Bucket hit					
	High	AC	90	0.56	
	Med	AD	26	1.39	
	Low	AE	25	2.00	
Corner Bucket Hit					
	Med	AB	27	1.85	
	Low	AG	65	0.77	
High Cycle Fatigue Cases Leveler					
	High	N	51	0.38	
	Med	V	52	0.37	
Trencher					
	Med	X	5	3.84	
	Low	S	67	3.27	
Digging					
	Med	V	36	0.53	
	Low	C	78	0.25	





Yield Criteria (50 ksi)

- Auger Bounce, Low is critical case



... within Epsilon



Fatigue Criteria (19 ksi?)



- Digging (low position) is fatigue critical case

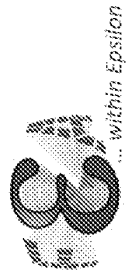
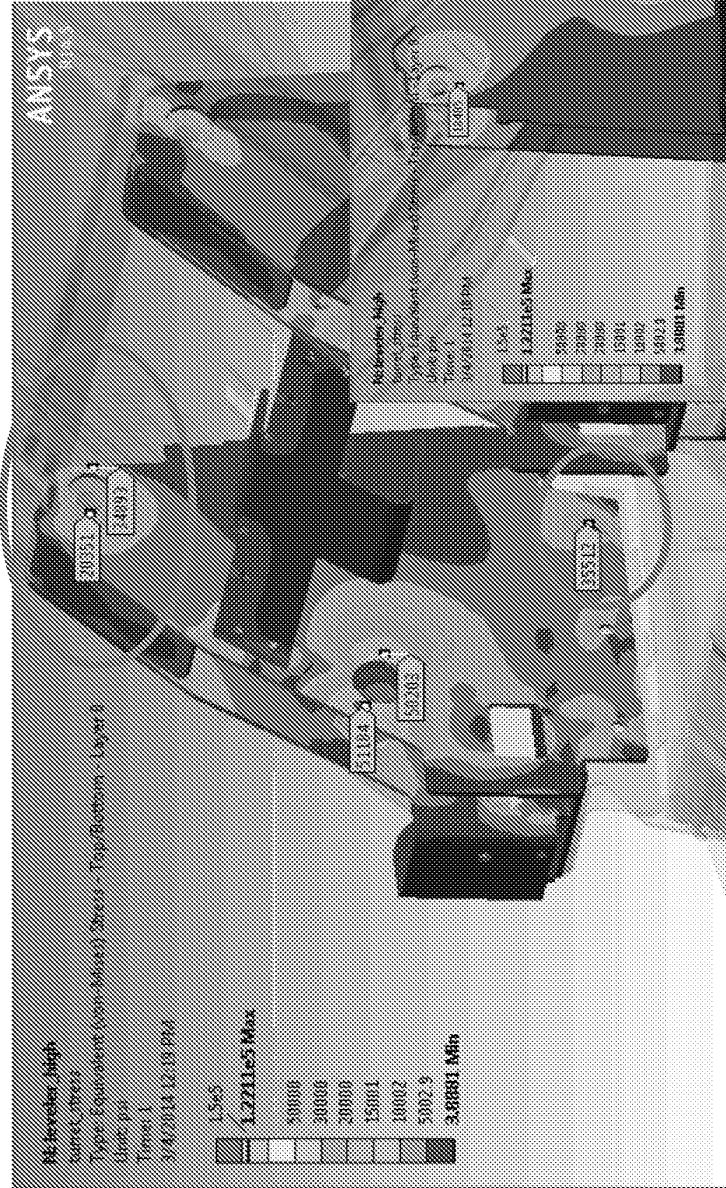




Fatigue Criteria (19 ksi?)

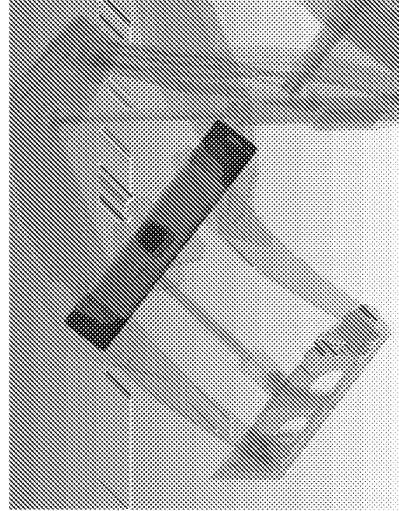
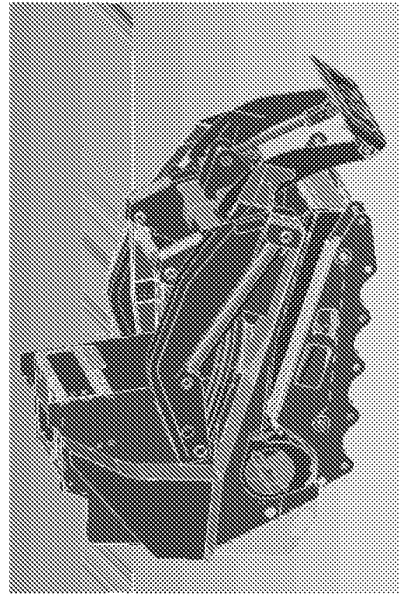


- Leveler (high position) is fatigue critical case
Load originates 32" below bucket



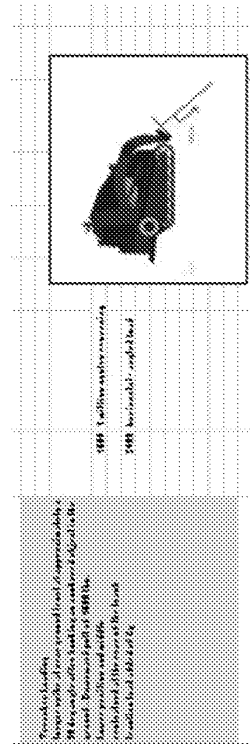


TMAX Loader Rectangular Torque Tube 03/03/2014





- Uses defined loads (21 cases)
- High Position - Leveler Load now originates 32" below bucket
 - And 12" forward





Summary



- See Excel sheets

	Case Label	Peak Stress		Axial Force (lb-ft)	Shear Load (lb-ft)	Torsional Moment		Short Moment (in-lb) MK	FX	FY	FZ	MX	MY	MZ	SMA_R0X	SMA_R0Y	SMA_R0Z	SMA_R0X	SMA_R0Y	SMA_R0Z	Total
		(ksi)	(ksi)			(in-lb) MK	(in-lb) MK														
Auger Bounce	High	F	48	0.94																	
	Med	U	70	0.84																	
	Low	S	74	0.81	-1.026	16.377	87.810	-80.856	-16.783	2.361	1.058	-14.716	-60.896	97.810	6.908	23.410	18.072	-36	6.124	52.294	
Offset Grapple	High	K	73	0.82																	
	Med	L	93	0.96																	
	Low	O	93	0.45	-1.038	3.714	180.260	-26.436	-3.397	2.237	1.695	6.793	-20.436	880.000	2.806	8.411	20.036	363	2.823	43.764	
Auger Hook-out Length	High	L	11	4.09																	
	High	S	6	2.56																	
Side Bucket Lift	High	AC	10	1.46																	
	Med	AD	11	4.09																	
	Low	AE	83	4.50																	
Corner Bucket Lift	Med	AB	5	9.00																	
	Low	AG	20	2.26																	
High Capacity Fatigue Corros	High	AI	80	0.18	-1.179	22.822	86.243	435.000	-2.269	-3.827	-1.779	-1.905E-04	-1.585E-05	3.625E-04	6.282	31.359	20.903	362	6.430	67.122	
	Med	Y	86	0.20																	
	Low	S	16	1.00																	
Trencher	Med	X	18	1.00																	
	Low	S	16.0	1.70																	
Digging	Med	V	12	1.42																	
	Low	C	11	1.55																	



... within Epsilon