



!"#\$%&'()&*+' , (- . /012" . 34(5, 6. 2() *76/%8(%7(% , (596&"+' : ;(5, 2. *0+' ;(
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>8(>&%: /' 8(?=(?'%8' 7
@AAB(C, : ' &D&%: . %2' (?", "&7(E4' 7*7
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J"96. 2' &(13* , 3' () ' 6%&29' , 2;(>"72" , (J"// ' D'

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E4' (. 7' ('H(: *&' 3213'' , 2%32(9% , *6. /%O'' , (6&'' +: ' 7(%(9''&' (, %2. &%/(^ , 2' &%30'' , (24% , (*7(%34*+ ' : (G8(24' (9'' . 7' ;(%+''* : * , D(24' (, ' ' : (2''(%G72&%32(3&. 3*%/(3'' , 3' 627(7. 34(%7(U7' /' 3O , DU:(U: &%DD* , DU:(''&(U' 7*O* , DU=(E4' (*, 2&'' : . 30'' , ('H(+*7'' , (: &*+' , (2'' . 3417' , 7*O+*28(%//'' \$7(H''&(24' (. 7' ('H(6487*3%/('GV' 327(2''(: ' , '' 2' (: *7O , 32(9' % , * , D7;(6&'' +: * , D(%(9' % , 7(2''(3&' %2' (%77'' 3*%O'' , 7(G' 2\$' ' , (6487*3%/(% , : (: *D*2%/(%3O'' , 7(=>. */: * , D(. 6'' , (24*7(3'' , 3' 62;(D' 72. &' (7. 66''&2*7(%/' D*3%/(% , : (6&%3O3%/ (3%6%G/*28(2'' (' K6' 32(H&'' 9%(U: *&' 32U(*, 6. 2(: ' +*3' =(F7(7. 34:(*2(*7(% , %/80' : (% , : (*96/' 9' , 2' : (%7(%(3''&' (3'' 96'' , ' , 2('H(

E%G/' ("H(J" , 2' , 27

5= (5, 2&" : . 30" , ((((Z

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555= E" . 3473&' ' , (! " # \$ % & ' (((R[

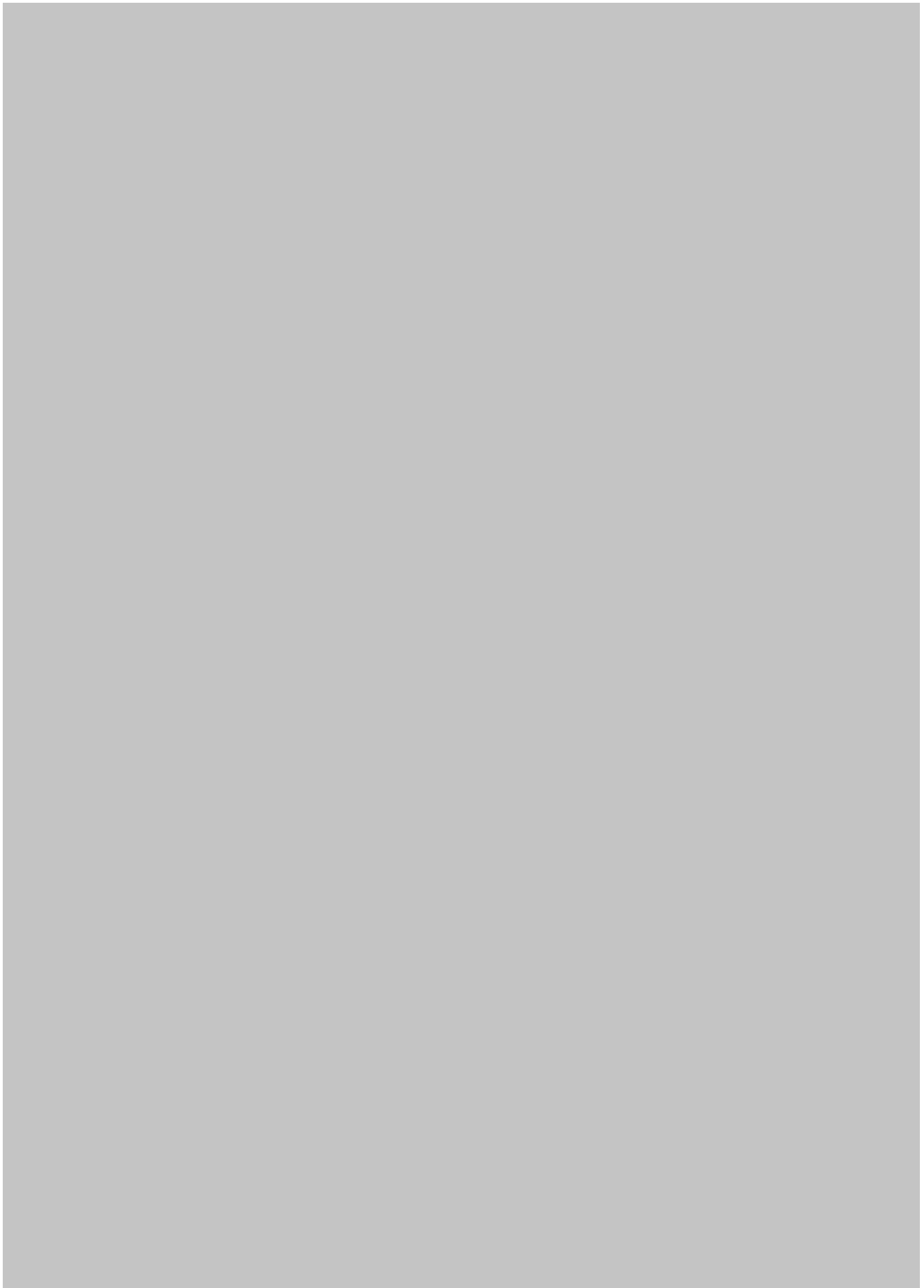
5\=) ' 6%&2. &' 7(H&" 9(E&%: *O" , %/(?1J5](E4' (F: "60" , (&"G/' 9 (((^A

\= I' /%2' : (L "&P (((^Z

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\55= F3P, "\$/' : D' 9' , 27 (((((((ZA

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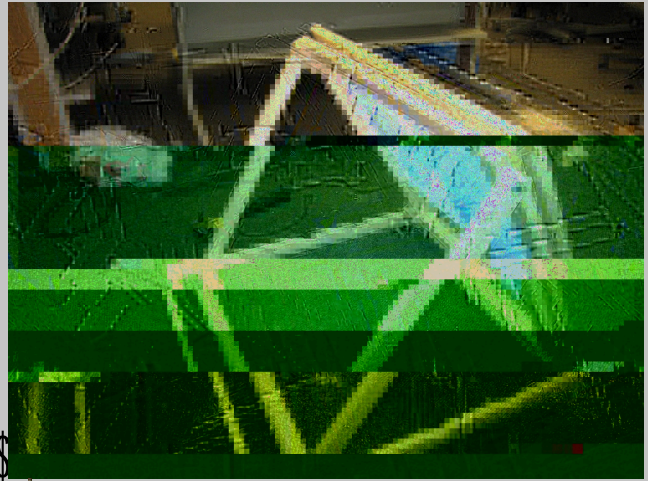
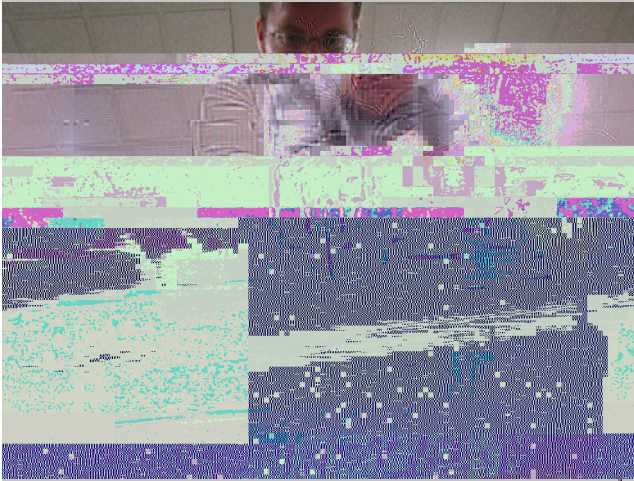
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<&'V' 32''&	MRN(! 4%&6(oI 1RROJ(<&'V' 32''&	_%O+' (RA@ZK[fB(I ' 7''/. O'' ,	nZmA
) * T . 7' &	MRN(! 4' ' 2('H(E&%3* , D(<%6' & MRN(J% , ('H(J/' %&:(! %O , (! 4' ' , (F3&8/*3((((((! 6&%8		

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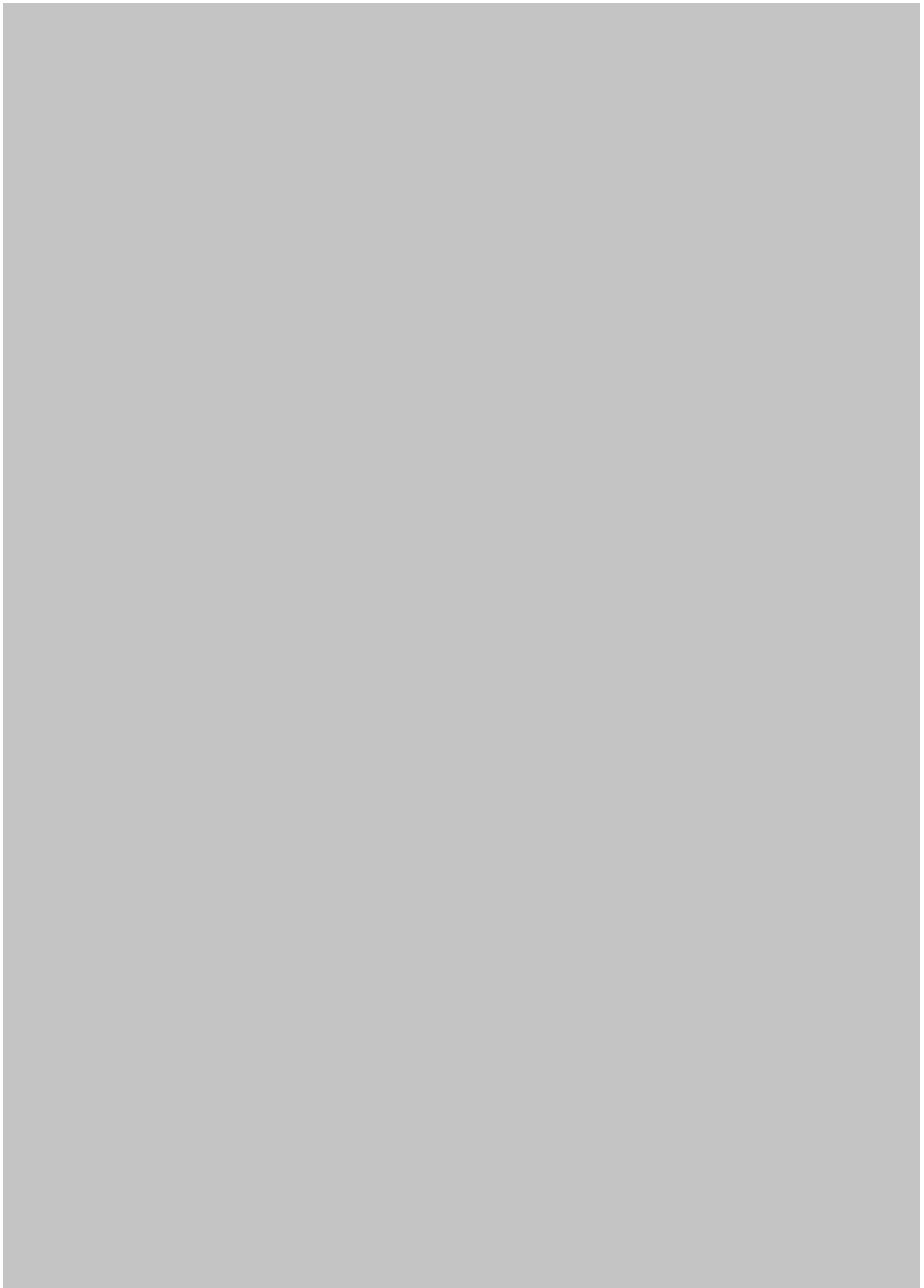
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F7(24*7(*7(%+' &O3%/18('&' , 2' : (73&' ' , ;(*2*7(' 3' 77%&8(2"(: ' 7*D, (%H" . , : %O" , (24%2(\$*1/(, "2(74*#("(&
9"+' (. , : ' &(6&' 77. &' (H&" 9("GV' 327(*, (3" , 2%32(\$*24(*2=>8(H"/'" \$*, D(24' 7' (*, 72&. 30" , 7;(*2(*7(6"77*G/' (2"
&' 6/*3%2' (24' (: ' +3' (G. *1/2(H" &(24*7(6&"V' 32]

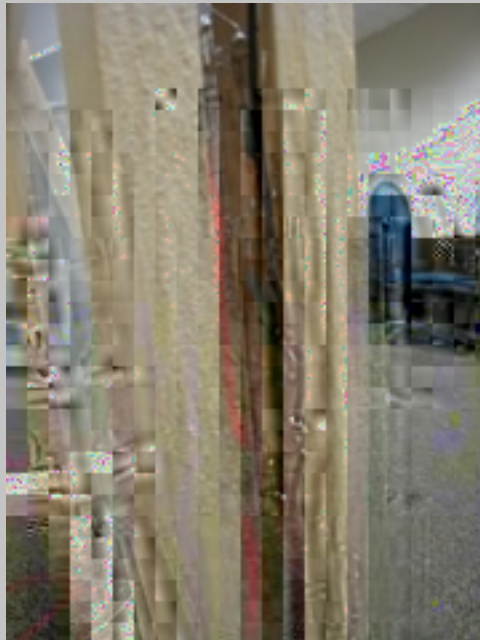
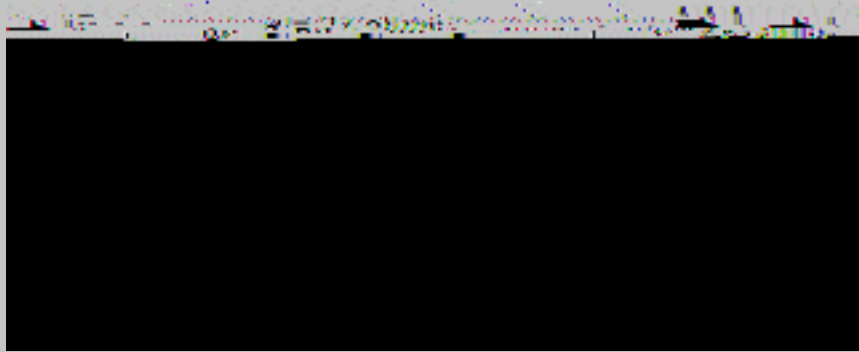
R= J" , 72&. 32(24' (73&' ' , (H&%9'

a*72;(G. */: (2\$"(: ' , O3%/(&' 32%, D. 1/%&(H&%9' 7(2"(G" &: ' &(8" . &(%3&8/*3(6%, ' /(" , (' %34(7*: ' =52(*7(
, ' 3' 77%&8(24%2(24' &' (G' (%66&"K*9%2' /8(% , (*, 34("H(3/' %&&, 3' (H&" 9(24' (" . 27*: ' (' : D' ("H(24' (
H&%9' (2"(24' (' : D' ("H(24' (D/77(*27' /H:(%7(24*7(*7(\$4' &' (24' (I g) 7(\$*/(G' (6/%3' : =

@= E&' %2(24' (" . 2' &(/%8' &("H(%3&8/*3(\$*24(24' (6"/8. &' 24%, ' (76&%8;(/'" \$*, D(Rm(9* , . 2' 7(2"(: &8=(q, 3'
3" 96/' 2' ;(6/%3' (24' (: *T. 7' &(G' 2\$' ' , (24' (2\$"(6%, ' 7("H(%3&8/*3;(9%*, 2%*, *, D(3%&' (2"(%+"*:



! " # \$ % . - (6 . * - 8



E4' (3*83. *27(. 7' : (4' &' (%&' (+' &8(7*96/' ;(G. 2(, . 9' &" . 7=E"(P' ' 6(24' (&' Y. *8' : (3. &&' , 2(2"(%
9* , *9. 9;(24' (lg) 7(" , (' %34(7* : ' (\$' &' (7' 6%&%2' : (* , 2"(H" . &(D&" . 67("H(24&' ' =E4' 7' (D&" . 67(\$' &' (\$*8' :(
* , (7' &* 7;(3" , , ' 32' : (* , (6%&%// ' /2"(24' (6" \$' &(7" . &3' =5(&' 3" 99' , : (4%+* , D(%2/' ' %72(m(76%&' (51 (lg) 7;(%7
24' 8(%&' (+' &8(H&%D*' (' , : (*2*7(' %78(2" (7, %6(" T(24' *8(3" , 2%327(\$ 4' , (2&8* , D(2" (7' 2(% , : (9% , *6. /%2' (24' 9(
* , 2"(24' *8(79%/(4" . 7* , D=5(72&" , D/8(&' 3" 99' , : (7"/: ' &* , D(V. 72(" , ' (3" 96/' 2' (M7' &* 7N(3*83. *2(2" D' 24' &
% , : (' +%/ . %0, D(24' (%: V. 729' , 27(24%2(\$*//G' (, ' 3' 77%&8(2" (j 2(*2* , 2"(24' (' , 3/" 7. &' =

F: V. 70, D(24' (3" , 2%32/' ' %: 7(" , (24' (lg) 7(*7(+ ' &8(: *W3. /2(2" (: "(9" &' (24% , (" , 3' (\$*24" . 2(3% . 7* , D(
24' 9(2" (G&' %P;(% , : (*2*7(%/9" 72(D. %&% , 2' ' : (24%2(8" . (\$*// , ' ' : (2" (3. 2(7" 9' (6" &0" , ("H(*2(2" , ' %2/8(j 2(

q, 3' (24' (1g) (3*3. *27(%&' (\$*&' : (% , : (j K' : (* , (6/%3' ;(6" \$' &(24' (3*3. *2(% , : (' K%9* , ' (*2(. 7* , D(%3' /(

64" , ' (3%9' &%" &("24' &(51 (7' , 7*0+' (*9%D' (3%62. &' (: ' +*3' =(q, 3' (*2(*7(+ ' &'j' : (24%2(%//("H(24' (1g) 7(%&' (

//. 9 , %2' : ;(: ". G/ 134' 3P(24' (7"/: ' &("** , 27(H" &(72%G*/28(M. , : ' &(& D. /%&(: ' +*3' (9" + ' 9' , 2X6*+"O, DN(% , : (

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D&" . , : (/ , ' 7;(%7(%7"/: ' &' : (3" , , ' 30" , (24%2(*7(G&"P' , (%#&' &(24' (: ' +*3' (*7(7' %/ : (3% , (G' (%(4%77/ ' (2" (

&' 6%*&=(F#&' &(* , 7' &O, D(24' (G"/27(* , 2"(24' (4* , D' 7;(24' (%66%&2. 7(\$*//G' (H. //8(3" , 72&. 32' : =(E4' (" , /8(*77. ' (

&' 9%* , * , D(*7(3%9' &(6/%3' 9' , 2=(F7(3% , (G' (7' ' , (* , (24' (%33" 96% , 8* , D(*9%D' ;(24' (\$' G3%9(*7(h%34' : (

2"(24' (&' %&(7. 66" &2("H(24' (G%7' ;(" &24" D" , %//8(" &* , 2' : (\$*24(&' 76' 32(2" (24' (%3&8/*3=(E4*7(" &24" D" , %/*28(*7(

, "2(72&*32/8(' , H" &3' : ;(%7(3%/*G&%O" , (\$*//8*" /: (%(4" 9" D&%648(2" (&' 9" + ' (24' (&' 7. /O, D(: *72" &O" , 7=

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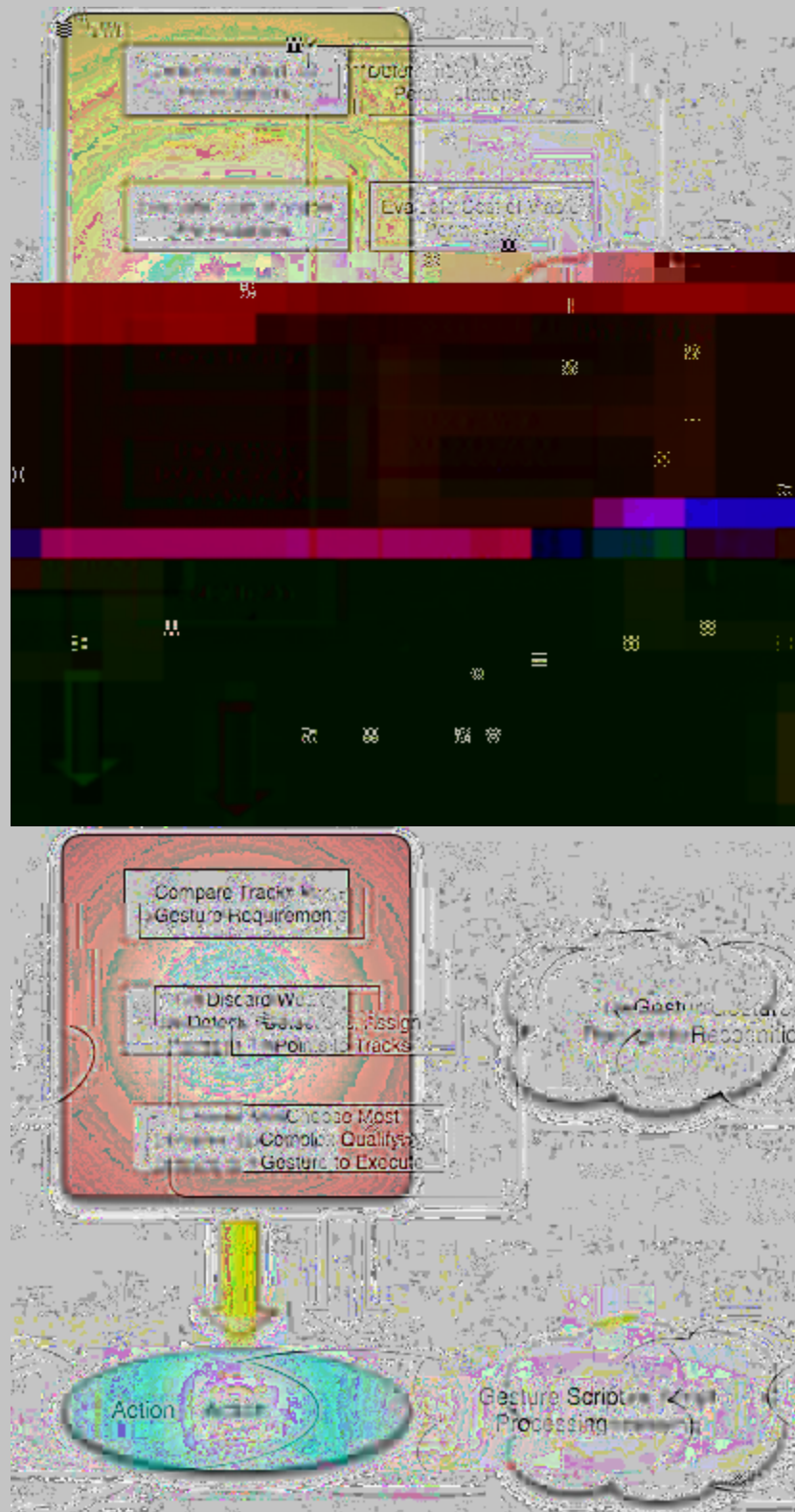






!"#\$%&'(a/"\$() *%D&%9





E#F#/&) 1 #' *\$G' F.-&' 1 #' *

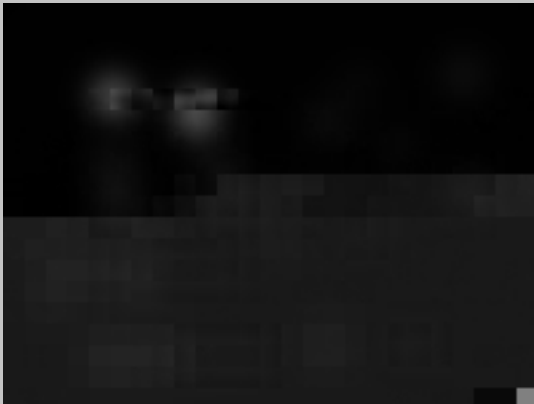
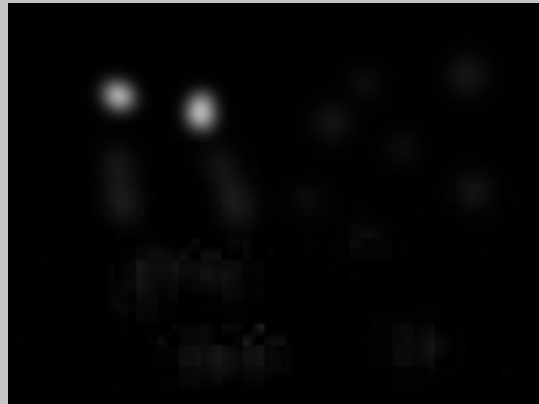
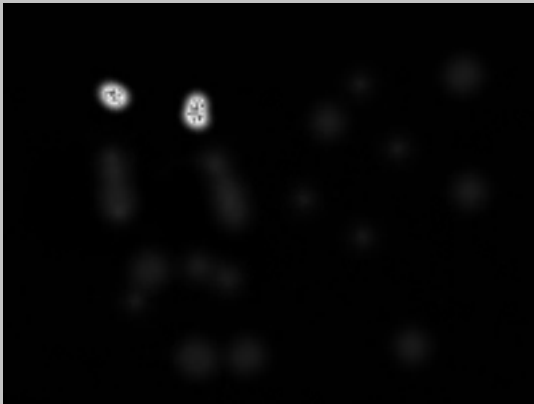
E4*7(7"#\$\$%&' (\$%7(: ' + ' /" 6' : (. 7*, D(- *3&"7"#(\^*7. %/(Jrr(@AAm=(E4' (2". 34(7"#\$\$%&' (*27' /H(&' Y. *&' 7(24' (q6' , J\(/*G&%&&8;(\$4*' (24' (+*7. %/*0%0" , (7"#\$\$%&' (&' Y. *&' 7(q6' , pl(% , : (24' () ' +5l(*9%D' (6&"3' 77* , D(/*G&%&&8=

%, 1 #-, \$H, ' | /.' :

a&%9' 7(%&' (3%62. &' : (H&"9(24' (\$' G3%9(%2(*27(, %0+' (&' 7"/. 0" , =(F7(\$' (%&' (: ' %/* , D(\$*24(j /2' &' : (* , H&%&' : (/D42:(%7* , D/' (34% , , ' /(*9%D' (*7(7. W3** , 2(2" (6&' 7' &+ ' (%//(&' /' +%, 2(: %2%=(F7(*2*7(286*3%/H"&(24' (H&%9' (&%2' ("H(24' (3%9' &%2" (G' (/9*2' : (G8(24' (' W3** , 38("H(24' (G/"G(*: ' , Oj 3%0" , (%/D" &*2497:(7*D , *j 3% , 2(* , 3&' 7' 7* , (6' &H" &9% , 3' (3% , (G' ("G2* , ' : (G8(73%/ , D(24' (* , 3" 9* , D(*9%D' (G8(%H%32" &("H(" , '(4%/H(" &(" , ' (Y. %&2' &=(E4*7(\$%7(, "2*96/' 9' , 2' : (* , (24*7(6%&O3. /%&(6%6' &:(%7(6&' 3*7** , (\$%7(: ' ' 9' : (9" &' (*96" &2% , 2(24% , (&%6* : (7%96/* , D=

J%9' &%3%/*G&%0" , (*7(3&. 3*%/2" (24' (. 7%G*28("H(24' (: ' +*3' =(E4*7(6&"V' 32(%33" 96*74' : (3%/*G&%0" , (G8(. 0/*0* , D(% , ("60" , %/(B16"* , 2(2" . 34(' K' &3*7' (" , (/%. , 34:(% , : (3%/3. /%0 , D(%4" 9" D&%648(G%7' : (" , (24' (*: ' , Oj ' : (G/"G(/"3%0" , 7(% , : (" , 173&' ' , (3"" &: * , %2' 7("H(24' (2%&D' 2(%&' %7(E4' (%66/*3%0" , (7%+ 7(24' (4" 9" D&%648(2" (*27(/"3%/H"/: ' &(. , O/(24' (, ' K2(3%/*G&%0" , (*7(&. , =(E4*7(6&" +*: ' 7%(9" &' (. 7' &(H&* , : /8(' K6' &* , 3' ;(%7(*2(Y. *3P/8(G' 3" 9' 7(2' : ** . 7(2" (3%/*G&%2' (' %34(O9' (24' (%66/*3%0" , (*7(/%. , 34' : =(E4*7(72' 6(. 0/*0' 7(*27(" \$, (&" . 0 , ' (H" &(*: ' , OH8* , D(G/"G7:(%7(6&' 3*7** , (*7("H(6%&%9" . , 2(*96" &2% , 3' =

J1 , : # \$ + , ' .) 6 / , 7 & '



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I ' 9'' +*, D(24' (G%3PD&' . , : (H&' 9(24' (*9%D' (%//'' \$7(H''&(% , (' %78(7''/. 0'' , (2'' (*77. ' 7(%&*7* , D(H&' 9(3'' , 72&. 30'' , ('H(24' (: ' +*3' =1*D42(/' %P%D' (*7%(3'' 99'' , (6&' G/' 9;(%7(24' (1g) 7(\$*//286*3%/8(6&'V' 32(Rm(: ' D&' ' 7(H&' 9(24' *&(06(* , (%//(: * &' 30'' , 7=5 , (24*7(6&'V' 32:(24' (1g) 7(\$' &' (b. 74(2''(24' (%3&8/*3(2''(9%K*9*0' (24' (* , 3'' 9* , D(/*D42(H''&(24' (73&' ' , (*27' /H=5 , 3* : ' , 2%/(: ' 2' 30'' , ('H(/*D42(H&' 9(24' (6&'V' 30'' , (: ' +*3' (*7(%/7'' (% , (*77. ' ;(%7(24' (6&'V' 32''&(G. /G(\$*//3%72(* , 2' , 7' (* , H&%&' : (/D42(' + ' &%(79%//(3*&3. /%&(&' D*' , (\$4*34(\$*//G' (&' b' 32' : (G%3P(* , 2''(24' (3%9' &%(+*(24' (: *T. 7*' , (9%2' &*%/(=>%3PD&' . , : (7. G2&%30'' , (*7(, "2%(3'' 96/' 2' (7''/. 0'' , (2''(24*7(6&' G/' 9;(%7(73&' ' , (0/2(%&*7' 7(H&' 9(, "&9%/(. 7%D' ;2&% , 7H''&9* , D(24' (&' D*' , (+ ' &O3%/8(* , (24' (j K' : (3%9' &%U7(+* \$=(a* , %/8;(24' (6''/8. &' 24% , ' (3''%Q D(6/3' : (' , (24' (%3&8/*3(' , 4% , 3' 7(24' (76' 3. /%&(

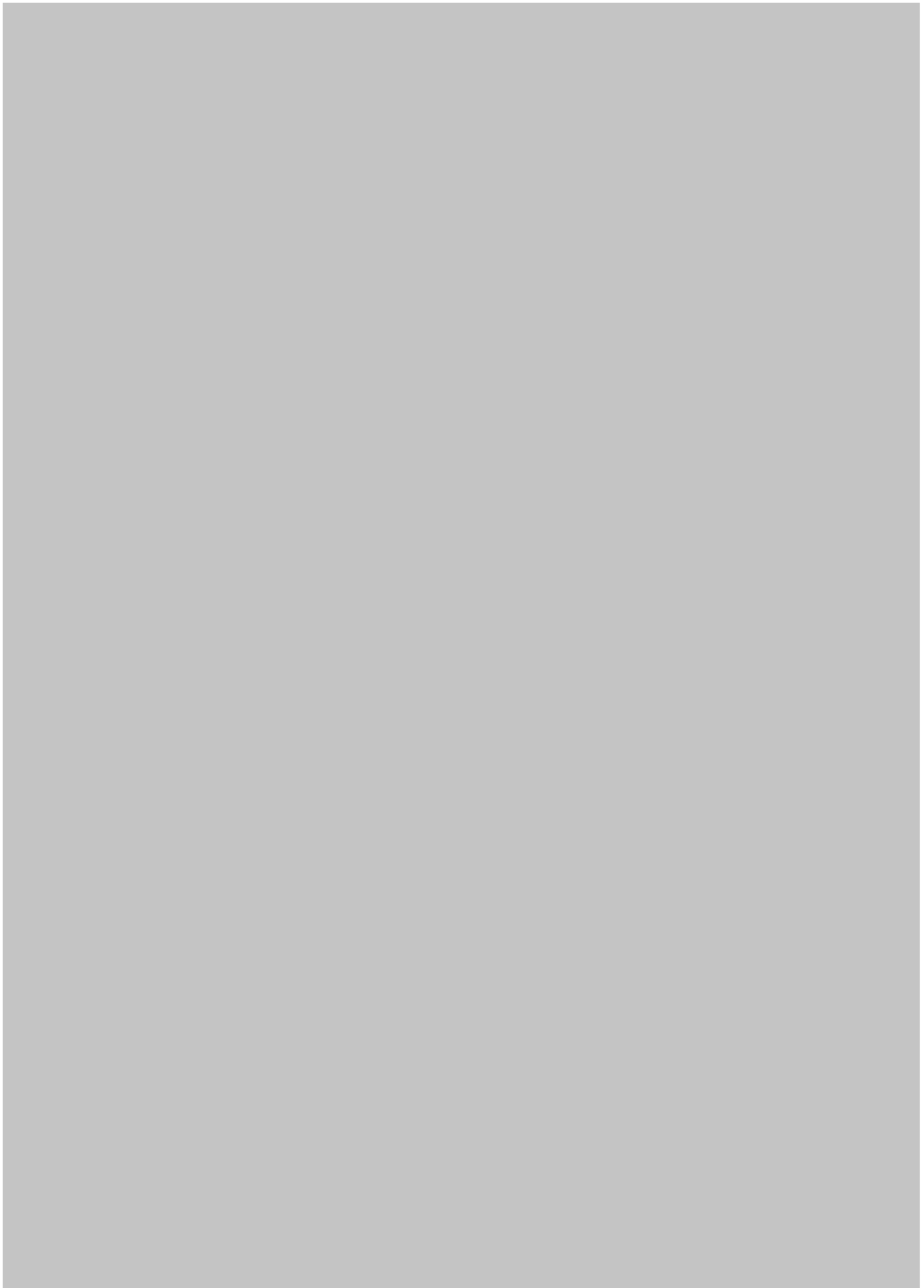
6&"6' &28("H(9%2' &*%/7(*, (3", 2%32(\$*24(24' (73&' ' , =E4*7(3%. 7' 7(: ' G&*7(2''(&' b' 32(' , '' . D4(/*D42(2''(D' , ' &%2' (H%/7' (6''7*0+' 7=

E''(*96&'+' (24' (: ' 2' 30'' , ("H(7*96/' (2'' . 34(*, 3*: ' , 27:(%2' 34, *Y. ' (9. 72(G' (' 96/'8' : (2''(*7''/2' (6' %P7("H(*, 2' , 7*28=>8(G/. &&* , D(24' (*, 3''9* , D(3%9' &%(*9%D' (\$*24%(79%/D%. 77*%, (P' &, ' /;(24' (79''''24' : (*9%D' (D*+' 7%(6/%, %&(&' 6&' 7' , 2%0'' , ("H(24' (73&' ' , (7. &H%3' =! 9''''24(6' %P7(%&' (' 76' 3*/8(4' /6H. /(*, (24%2(24' 8(: *76' &7' (. , *, 2' , : ' : (&' b' 30'' , ;(% , (' K%96/' (G' * , D(%(6%&2("H(24' (. 7' &U7(4% , : (*, (3''7' (6&'K*9*28(2''(24' (73&' ' , (7. &H%3' =>8(G/. &&* , D(24*7(79''''24' : (*9%D' (G8(%(7/*D42/8(/%&D' &(D%. 77*%, (P' &, ' /(% , :(3'' , 7' Y. ' , 2/8(7. G2&%30, D(24' (2\$'';(" , /8(24' (6' %P7(\$*/(&' 9*%, =F//("24' &(3''96'' , ' , 27(\$*/(G' (' /*9* , %2' : (G8(G/. &&* , D(24' (9''&' (*, 2' , 7' (6' %P(2''(24' (\$' %P' &(%&' %7(\$*24* , (24' (&: *. 7("H(24' (2'' . 34(&' D*'' , =

K/&<\$E#*#(7&'



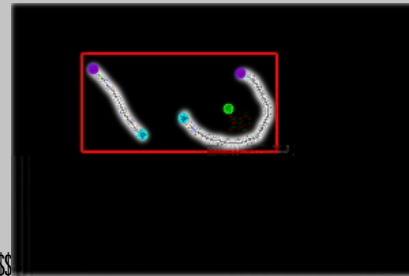
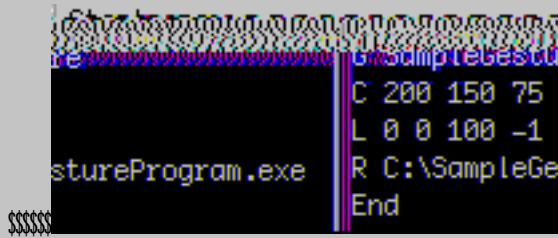
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3' , 2' & ' : (%2(24' (2&%3PU7(/%72(&' D*72' & ' : (6'' , 2;(24' (73''&* , D(H. , 30'' , (\$*//(&' V' 32(*2(%7(% , (* , +%/* : (3'' 9G* , %O'' , =(E4' (7' 3'' , : (j /2' &(6' &H''&97(+ ' /''3*28(3'' 96%&*7'' , 7;(&' 72&*30, D(%33' /' &%O'' , (% , : (: ' 3' /' &%O'' , (2''(%(3' &2%* , (6''7*0+' (6' &3' , 2%D' (& , D' =(E4*7(+ ' /''3*28(9' %7. &' 9' , 2(''33. &7(* , : ' 6' , : ' , 2(''H H&%9' (&%2' ;(G. 2(&%24' &(*7(6%3' : (+*%(' /%67' : (09' (%7(3%/3. /%2' : (G8(24' (: *T' &' , 3' (* , (3/''3P(383/' 7(%2(24' (09' (''H(7%96/* , D=(E4*7(*7%33. &%2' (2''(%66&''K*9%2' /8(RXRAAA

\$' *D42' : (7"/. 0" , (3" , , ' 30, D(%//6" , 27(%, : (2&%3P7(M: ' j , * , D(24' (3&' %0" , ('H(%(, ' \$(2&%3P2"(G' (%(9%234(
G' 2\$' ' , (%(6" , 2(%, : (24' (, . //c(2&%3PN(*7(24' , (6%77' : (" , (2"(24' (2&%3P(3&' %0" , (% , : (9% , *6. /%0" , (
9" : . /' =(E4*7(: %2%(*7(. 0/*0' : (2"(9%P' (24' (6&"6' &(3" , , ' 30" , 7(G' 2\$' ' , (24' (2&%3P7(%, : (6" , 27:(. 7* , D(
, . //19%234' : (6" , 27(%7(4' %: 7("H(, ' \$(2&%3P7=(E"(7"/+' (24' (*77. ' ("H(, * , 2' , 0' , %/(3" , 2%32(%, : (6" , 2(
&' D*72&%0" , ;(, ' \$(6" , 27(H%*/ , D(2"(4%+' (9' % , (* , 2' , 7*28(7%07H8* , D(24' (3" , j : ' , 3' (24&' 74"/: (6%*&' : (\$*24(
24' (, . //c(2&%3P(%&' (: *73%&: ' : ;(%7("66"7' : (2"(G' * , D(*: ' , Oj ' : (%7(, ' \$(2&%3P7=

M#0*6-#\$N#(&: ' .7&'



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E4' (/%, D. %D' (. 7' : (2'' (' K6& 77(D' 72. &' 7(7(3'' 96'' 7' : ('H(/* , ' %&(% , : (3*&3. /%&(3'' 96'' , ' , 27=(E4' (
D' 72. &' (%. 24'' &(9%8(&' j , ' (24' 7' (' K6& 77'' , 7(G8(7' K , D(%(+%&* 28('H(6%&% 9' 2' &7=I* , ' %&(: ' j , *O'' , 7(
&' Y. *&' (%66&' K*9%2' (/ , D24;(7/' 6' :(% , : (3'' '&: * , %2' 7(9%66' : (* , (&' /%O'' , (2''(24' (2'' 61/' # (3'' & , ' &('H(24' (
D' 72. &' (G'' . , : * , D(G'' K=(J*&3. /%&(3'' 96'' , ' , 27(&' Y. *&' (%66&' K*9%2' (&: **(* , (%: : *O'' , (2''(24' (&' /%O+' (

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p' 72. & 7(%&' (: ' j , ' : (24&'' . D4(%7*96/' (6/% , 2' K2(j /' (H''&9%2=(o- l(9%8(9%P' (H''&%(9''&' (. 7' &1H&'' , : /8
H''&9%2;(G. 2(*27(+ ' &G''7*28(/*9*2' : (*27(. O*28(H''&(24' (6&''V' 32(%2(4% , : =(E4' (H''//'' \$* , D(78, 2%K(*7(. O*0' :]

!2%&2
p(wp' 72. &' (_%9' x
wJ'' , 72&%' , 27x
wF30'' , 7x
g, :

E4' (U72%&2U(P' 8\$''&: (7*D, *j' 7(24' (G' D* , , * , D(''H%(D' 72. &' (: ' j , *O'' , ;(\$4*' (24' (U' , : U(P' 8\$''&: (3/'7' 7(24' (
' , 2&8=(52(*7(286*3%/;(G. 2(, ''2(&' Y. *&' : ;(2''(6/%3' (24' (6&' &' Y. *7*2' 7(H''&(' K' 3. O' , (%2(24' (72%&2(''H(24' (
: ' j , *O'' , =(E4' ('&: ' &(''H(&' Y. *&' 9' , 27(*7(, ''2(3'' , 7*: ' &' : (: . &* , D(' +%/ . %O'' , ;(G. 2(24' ('&: ' &(''H(%30'' , 7(
: *32%2' 7(24' ('&: ' &(''H(' K' 3. O'' , =

J*3. /%&(J''96'' , ' , 27

E4' (78, 2%K(H''&%(3*3. /%&(2&%3P(&' Y. *&' 9' , 2(*7(%\$OAP\$OQP\$ON3EJRS\$J2\$9JAG>SP=(F//(+%/ . ' 7(9. 72(G' (
* , 2' D' &7;(24' (%(G' * , D(24' (D' 72. &' (P' 8\$''&: (2'' (*: ' , CH8(24' (/ , ' (%7(%3*3. /%&(2&%3P(&' Y. *&' 9' , 2(: ' j , *O'' , =

I* , ' %&(I' Y. *&' 9' , 2

E4' (78, 2%K(H''&%(/* , ' %&(2&%3P(&' Y. *&' 9' , 2(*7(>\$OAP\$OQP\$O>G2M! H\$J2\$9JAG>SP\$OS>T9GP=(F7(\$*24(24' (
3*3. /%&(78, 2%K;(%//(+%/ . ' 7(9. 72(G' (* , 2' D' &7(7%+' (H''&(24' (7/'6' (6%&9' 2' &=

F30", (I'Y. *8' 9', 2

52(*7(6"77*G/' (2" (& , (% , (%66/*3%0" , ;(7*9. /%2' (%(9" . 7' (' +', 2;('&(' 9. /%2' (P' 8G"%&: (* , 6. 2(\$*24%(D' 72. &' (

%30" , =

F30", (E86'	5: ' , Oj ' &	F&D. 9' , 27	gK%96/'
gK' 3. 2' (F66/*3%0" ,	g	M! 2&*, DN(<%24(2" (j /'	g(Jjy98F66=' K'

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_dC(I ' 7' %&34' &(e' T' &7'' , (?%, (j &72(6&' 7' , 2' : (4*7(%66/*3%0'' , ('H(H&. 72&%2' : (2''2%/(*, 2' &, %/(
&' b' 30'' , (2''(9. /012'' . 34(: ' 2' 30'' , (*, (@AAm(0@s={a' %2. &' : (%2(Eg) ;(4*7(6%6' &(% , : (7. G7' Y. ' , 2(
6&' 7' , 2%0'' , (+%. /2' : (9. /012'' . 34(*, 2''(24' (6. G/*3(' 8' =52(3%, (3' &2%* , /8(G' (%&D. ' : (24%2(24' (6/' 24''&('H(
%+%*%G/' (D&%64*3%/(: ' 9''7(6&''+* : ' (H''&(% , (' , 2' &2%* , * , D(: ' 9'' , 72&%0'' , ;(8' 2(%7(%(3'' , 7' Y. ' , 3' (24' (
3''99'' , (3%7' (4%7(G' ' , (\$''' H. //8(. , : ' &: ' + ' /''6' : =! 6' 3%*28(%66/*3%0'' , 7(%&' (3/' %&G' , ' j 3%*&* 7('H(24*7(
2' 34 , ''/'D8;(8' 2(24' (2'' . 3473&' ' , (*7(, ''2(&' %: *78(&' 6/%3* , D(24' (P' 8G''%&: (% , : (9'' . 7' (H'' &(72% , : %&: (7' (
3%7' 7=E'' . 34(2' 34 , ''/'D8(' K*727(* , (%+%&* 28('H(9% , *H' 72%0'' , 7;(H'' 9(' G/' , : c(2'' . 34(6%: 7(% , : (9' : *(
6/%8' &(3'' , 2&''/7(2''(2'' . 3473&' ' , (9'' , *2''&7=F7(24' (2' 34 , ''/'D8(G' 3''9' 7(34' %6' &(% , : (/ 77(: ' /'3%2' : (*2(\$*/(
G' 3''9' (\$* : ' /8(&' 3''D , *0' : (%7(%(9''&' (/''D*3%/(% , : (*, 2. *0+ (*, 2' &%30'' , (9' 24'' : ''/'D8=E4' (*, 2&' : . 30'' , (
''H(2'' . 3413' , 2&*3(*, 2' &H%3' 7(\$*/(6&''+* : ' (, . 9' &' . 7(%: : *0'' , %/(G' , ' j 27;(*, 3/. : * , D(3/' % , ' &(*, 2' &H%3' 7;(
9''&' (' W3'' , 2(\$* , : ''\$(9% , %D' 9' , 2:(% , : (24' (%: + , 2('H(%(/ 77(&' 72&*30+ ' (+*&2. %/0%0'' , ('H(6487*3%/(
\$* &/: (3'' , 3' 627(*, (7''#\$%&' (%66/*3%0'' , 7=

E'' . 34(4%7(, ' 3' 77%&*78(H%*/' : (2''(&' 6/%3' (24' (3. &&' , 2(72% , : %&: (%7(L5- <(*, 2' &H%3' 7(: '' , ''2
2&%, 7/%2' (\$' //2''(2'' . 3413' , 2&*3(*, 6. 2(: ' +*3' 7=E4*7(3%, (/ %&D' /8(G' (%h&*G. 2' : (2''(24' (3/. h' &(2''/' &%, 3' (
%T''&: ' : (G8(24' (%G72&%30'' , ('H(24' (6''* , 2' &(H&'' 9(: *&' 32(3'' , 2%32(2''(%(: ' +*3' (&' 6&' 7' , 2' : (' , 173&' ' , =>E
. 0/*0* , D(3/. 72' &7('H(79%//(*3'' , 7(% , : (24. 7(: ' 9% , : * , D(6&' 3*7' (*, 2' &%30'' , 7;(24' (*, 2' &H%3' 7(286*3%/('H(
2'' : %8U7(%66/*3%0'' , 7(' K4*G*2%(72' ' 6' &(/' %& , * , D(3. &+ =) *+* : * , D(24' 7' (6% , ' /7(*, 2''(7' 6%&%2' (: *%/'D7(
6%&0%/8(%// ' +*%2' 7(24' (6&' 6' , 7*28(H''&(3'' , H. 7'' , ;(8' 2(70//(*, 2&' : . 3' 7(24' (7%9' (*77. ' 7=>8('609*0* , D(% , (
* , 2' &H%3' (H'' &(2'' . 34(*, 2' &%30'' , ;(7*96/j 3%0'' , ('H('60'' , 7(% , : (3/' %&(6&' 7' , 2%0'' , (%&' (, ' 3' 77%&8=E4' (
. 0/*0%0'' , ('H(2'' . 34(%T''&: 7(9% , 8(9''&' (9' 24'' : 7('H(*, 2' &%30'' , (24% , (24' (72% , : %&: (3/*3P(3'' 9G* , %0'' , ('&
: &%D=E4' ('GV' 32(&' 3''D , *0'' , (6''2' , 0%/(*, 4' &' , 2/8(%+%*%G/' (G8(aE5I 1G%7' : (2'' . 34(: ' 2' 30'' , (%//'' \$7(H''&
6487*3%/('GV' 327(2''(&' 6&' 7' , 2(2''''/G%&7;(: *%/'D(\$* , : ''\$(%30+%0'' , 7;('&'(24' &(3''99'' , (*, 2' &H%3' (
3''96'' , ' , 2(%30'' , 7=E4*7(3'' , 3' 62(3%, (G' (' K2' , : ' : (G' 8'' , : (*, : *+* : . %/(%66/*3%0'' , (*, 2' &%30'' , 7;(%7(24' (

G/. &&*, D("H(24' (6487*3%/X: *D*2%/(: *+*: ' (%//'' \$7(H''&(' '+ ' /('9' 24": 7("H(: ' 7P2''6(9%, %D' 9' , 2(%7(\$' //=
F30" , (: *T' &' , 0%O" , (*7(+%72/8(*96&''+' : (\$*24(%9. /O12'' . 34(3%6%G/' (: '+*3' =(L* , : "\$(
9%, %D' 9' , 2(*7(%3/' %&(G' , ' j 3*%&8("H(24*7(' T''&2' 77(: *T' &' , 0%O" , =>8(*, 2&": . 3* , D(6&' 77. &' ("&(3" , 2%32(
6''* , 2(Y. % , O28(%7(9' 2&*37:(*2*7(, ''/'' , D' &(%&' Y. *&' 9' , 2(24%2(76' 3*j 3(%&' %7("H(\$* , : "\$7(G' (&' 7' &+ : (H''&
6%&O3. /%&(H. , 30" , 7=[E4' (9''72("G+'' . 7(/*9*2%O" , ("H(3. &&' , 2(\$* , : "\$ (9%, %D' 9' , 2(*7(24' (\$* , : "\$ (O2/' (
G%&U7(: ' 7*D, %O" , (%7(%(4% , : /' (2''(3" , 2&''/(&' /' 3%O" , =52(*7(, ''/'' , D' &(' 3' 77%&8(2''(3&' %2' (7. 34(
%33''99" : %O" , 7;(%7(% , (%30" , (%P* , (2''(: &%DD* , D(24&' ' (j , D' &7(H&''9(\$*24* , (24' (\$* , : "\$U7(H&%9' (*7(Y. *2' (
: *70, 32(H&''9(% , 8(P* , : ("H(*, 2. *O+' (3/*3P(' 9. /%O" , =[E4*7(/''D*3(3%, (G' (' K2' , : ' : (2''(4% , : /' (24' (9%W''&*28("H(
7. 34(%33''99" : %O" , 7;(*, 3/ : * , D(24' (U&' 7*0' U(4% , : /' ;(9* , *9*0%O" , (% , : (9%K*9*0%O" , (G. h" , 7;(% , : ('+' , (
6&''D&%9(2' &9* , %O" , =(p' 72. &' (&' 3''D, *O" , (H. &24' &' K2' , : 7(24' (. O/*28("H(9. /O12'' . 34(3%6%G/*28=(F7* : '
H&''9(%(3%7. %/(&' 6/3' 9' , 2(H''&(P' 8G''%&: (74''&23. 27;(' , ' (%+''* : 7(24' (, ' 3' 77%&8(3" , 2' K2(7\$*234(G' 2\$' ' , (
P' 8G''%&: (% , : (9" . 7' (\$4' , (. O*0* , D(% , 8(P* , : ("H(U7O3P8U(%30" , (M' =D=(34''''7* , D(%(6%* , 2G&. 74(2''''/;('6' , * , D(
%7' /' 30" , (: *%/'D;(' 23=H=[E4*7(7. G7O2. O" , (%+''* : 7(24' (* , '+*2%G/' (&' : . 30" , (* , (6&": . 30+*28(' K6' &'' , 3' : (
: . &* , D(% , 8(3" , 2' K2(7\$*234(G' 2\$' ' , (* , 6. 2(: '+*3' 7=

gK6/'&* , D(24' ("66''&2. , *O' 7(%T''&: ' : (G8(24' 7' (3" , 3' 627;(*2*7(' +*: ' , 2(24%2(24' (%G72&%30" , ("H(
6487*3%/3" , 3' 627(*, 2''(%(: *D*2%/(' , +*&' , 9' , 2(*7(, "2(" , /8(H' %7*G/' (G. 2(+*2%/2''(24' (7. 33' 77("H(9. /O12'' . 34(
%: "6O" , =[E4' (" . 2: %2' : (72% , : %&: ("H(24' (j K' : 1&' 7''/ . O" , (: ' 7P2''6(4%7(G' ' , (6%&O%/18(&' * , +*D''&%2' : (G8(
24' (3" , 3' 62("H(U9. /O6/' (: ' 7P2''67U;(8' 2(9" : ' & , (*96/' 9' , 2%O" , 7(/%3P(24' (b. *: *28(2''(%66' %/2''(24' (
3''99" , (. 7' &=(p*+' , (24' (3%6%G/*28(2''(*, 2. *O+' /8(, %+*D%2' ('+' &%(j

52(*7(3/' %&(24%2(24' (9''72(7. G72%, 0%/(('G72%3/' (2''(9. /012'' . 34(%: ''60'', (*, (9%*, 72&' %9(3''96. 0, D(

7(24%2(, 2' &H%3' 7(4%+' (G' ' , (: ' 7*D, ' : (72&*32/8(H''&(P' 8G''%&: (% , : (9'' . 7' (: &*+' , (*, 2' &%30' , =(E%P*, D(3%&' (

2''(: ' 7*D, (H''&%(2'' . 341: &*+' , (: ' +'3' (, ''2('' , /8(6&' 7' , 27%(9''&' (/ . 3*: (% , : (' W3*' , 2(' K6' &*' , 3' ;(G. 2(%/7''(

%//'' \$7(H''&(D&' %2(%: +% , 3' 9' , 27(*, (3''/1%G''&%0+' (6&' 3' 77' 7=() ' j , * , D(6487*3%/(('GV' 327(2''(4%+' (: *D*2%/(

%30'' , 7(' K6% , : 7(24' (&' 6' &2''&' ('H(24' (*, 2' &H%3' (: ' 7*D, ' &*(, (%: : *0'' , (2''(: *77*6%0, D(24' (: ' , 7*28('H(

H. , 30'' , %/*28(24%2(286*3%/18(6/%D. ' 7(3''96/*3%2' : (*, 2' &H%3' 7=(L 4*/' (D' 72. &' 7(9%8(G' (*96/' 9' , 2' : (H''&

. 7' (\$*24(24' (9'' . 7' ;(24' 8(%&' (, ''2(%7(' T' 30+' (%7(24''7' ('H(%(9. /012'' . 34(73&' ' , (H''&(/%3P('H(G''24(%

. , *Y. ' (9' 24'' : ('H(: *70, 30'' , (H&' 9(, ''&9%/(9''+' 9' , 2(% , : (&, D' ('H(9''0'' , 7(''&(6%h' & , 7(%+%/%G/' =

- . /012" . 34(7. &H%3' 7(4%+' (G' ' , (*96/' 9' , 2' : (G8(9% , 8;(H&" 9(9%V""&(3""&6""&%0' , 7(M- *3&"7""#;(

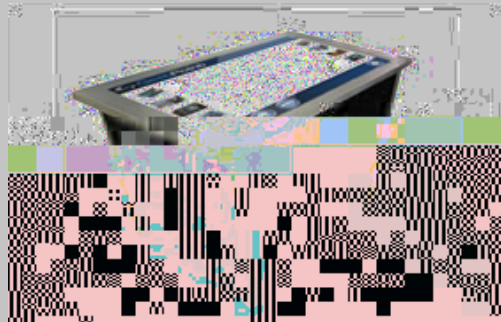
- *27. G*74*;<' &3' 60+' (<*K' /;(' 23=N(2""(4""GG8*72(: ' +' /""6' &7=F7(24' (3""72""H(24' (&' Y. *&' : (2' 34, ""/' D&

: ' 3&' %7' 7;(9""&' (* , , ""+%0" , (\$*//(' , ' 3' 77%&*78(' 33. &(* , (24*7(76%3' =L *//%9(<%3P' &('H(24' (- 5E(F&34*2' 32. &' (

- %34* , ' (p&"" . 6(' K6/""&' : (24*7(3"" , 3' 62(* , (24' (R{ [AU7;(: ' +' /""6* , D(%(: ' 7*D, (+' &8(7*9*7%&(2""(24""7' (H""/"" \$' : (



QmS



0fS



<4*67(g, 2' &2%G/' (Q[S



I ' %3E%G/' (QBS

Future work to be explored with this project resides in the realms of advanced gesturing, infinite resolution desktop environments, algorithm optimization, and deriving physical representations for digital actions.

Advanced Gestures

In order to avoid the need for the creation of a complicated scripting language for action definition, most complex gestures can be implemented via standalone executable files. These can then in turn be activated by a “run application” action from within the touch detection/analysis application.

Infinite Resolution Desktop Environments

The rigidly defined notion of a rendered window has steadily been redacted, with the introduction of graphically advanced window management software. One particularly relevant example is that of Beryl. Already merging 3D geographic manipulation with window management, it is a short leap to implement an infinitely large plane to contain application windows. The largest problem with such a concept is dealing with the infinitude of space, preventing lost windows. This issue can be mitigated via the introduction of bookmarks, bringing the frame to specified coordinates at a

Algorithm Optimization

As the current implementation works at frame rates in the range of 8 – 12 frames per second, the operating speed is far from the desired 30 frames per second. This is likely due to both the intense image processing required each frame and the webcam used.

Bridging the Physical/Digital Divide

The ability to perform silhouette recognition allows for previously unexamined interactions. Implementing an algorithm such as SIFT (scale-invariant feature transform) to detect and recognize objects in close proximity to the screen surface will enable physical objects to trigger actions within the touch detection/analysis software. One particular manifestation of the utility of such functionality lies in representing applications as blocks or other desktop-sized object. By placing a block against the

VII. Acknowledgements

QRS(4h6]XX\$\$\$172%03=33=D%2' 34=' : . X3/%77' 7X37f[mR|{[| \$*, 2' &XE'' 637X: */''D1\$*96X
Q@S(?%, ;e;(l '' \$1J''72(- . /O1E'' . 34(!' , 7*, D(24&'' . D4(a&. 72&%2' : (E''2%/5, 2' &, %/(l ' b 30'' , =5, (<&'3' ' : *, D7(
''H(24' (RB24(F, , . %/(FJ- (!896''7*. 9('', (C7' &(5, 2' &H%3' (!''#\$%&' (% , : (E' 34, ''/'D8;(@AAm
Q^S(4h6]XX6"D. '=G/'D7=, 809' 7=3''9X@AA[XA^X@[X24' 19. /O12'' . 34173&' ', X(L *l/%9() '' , ' /7'' ,
QZS(4h6]XX\$\$\$=9' &/=3''9X6&'V' 327X) *%9'' , : E'' . 34X
QmS(4h6]XX\$\$\$=6''6. /%&9' 34%, *37=3''9X2' 34, ''/'D8X* , : . 72&8XZ@R[^ZB=429/}6%D' t@
QfS(4h6]XX\$\$\$=D' 72. &' 2' P=3''9X*//. 9* , %2' X6&' : . 327''/. O' , 7|*//. 9* , %2' 2%G/' =646
Q[S(4h6]XX\$\$\$=&' 7' %&34=64*/67=3''9X* , *O%O+' 7X' , 2' &2%*G/' X
QBS(4h6]XX&' %32%G/' =. %=. 6H=' : . X